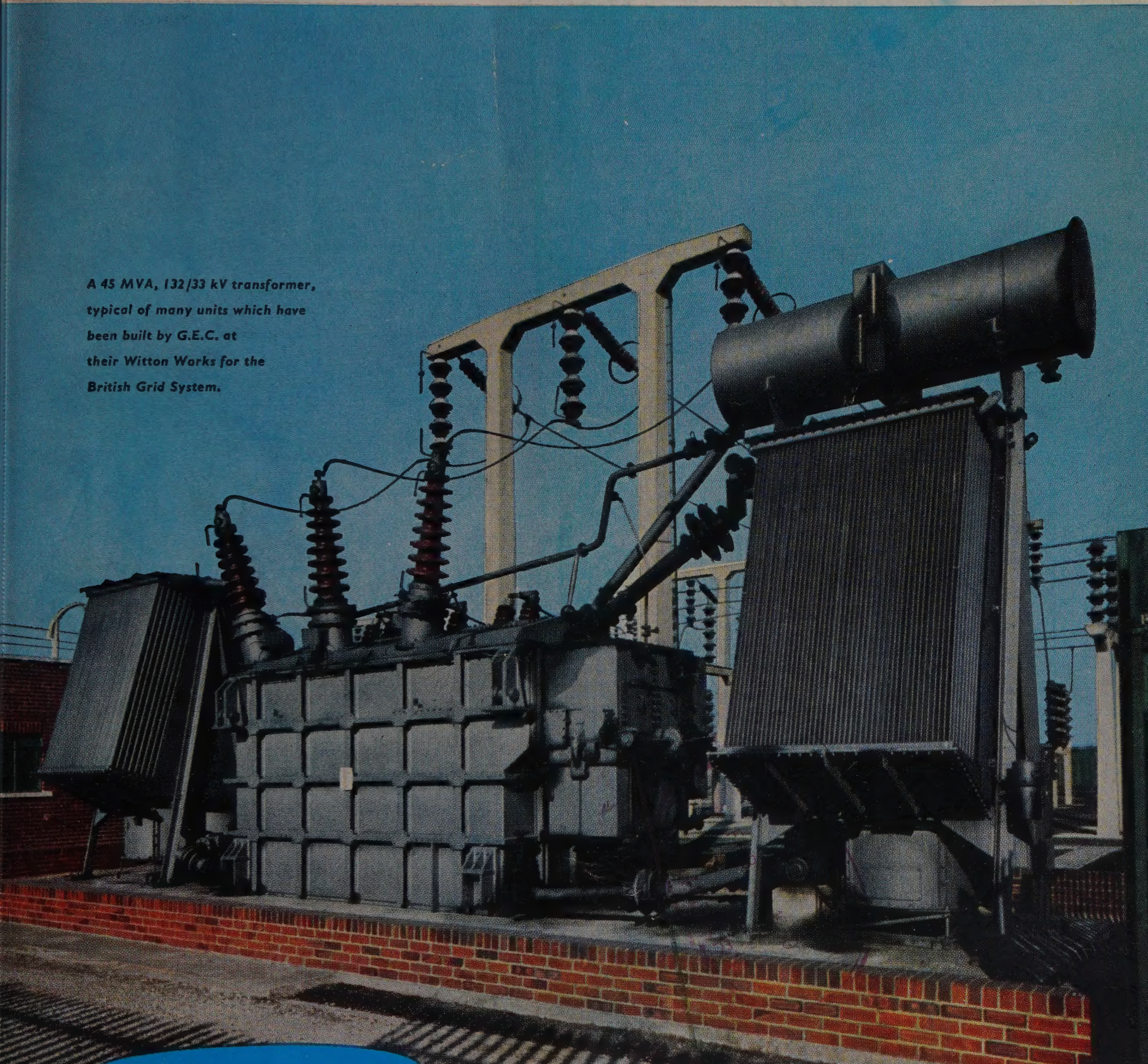
ELECTRICAL REVIEW

FRIDAY
22 JANUARY 1960

WEEKLY
PRICE 1s 6d



A 45 MVA, 132/33 kV transformer, typical of many units which have been built by G.E.C. at their Witton Works for the British Grid System.

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transformers for the world

THE GENERAL ELECTRIC CO. LTD. MAGNET HOUSE, KINGSWAY, LONDON, W.C.2

safety first with AEI earth leakage circuit breakers

Four types of earth leakage circuit breakers make up the AEI range of these established safety switches. Voltage operated and complying with B.S. requirements, they are of improved design and ensure a wide margin of safety. Tripping mechanism is simple and robust; cases and covers give good protection against dust and insects. For full details, please ask for catalogue Z174/57.

60 amp TP and TP & N

CATALOGUE No. PM.60T and TN

For industrial use. Supplied with or without overload coils on each phase, and with or without neutral link. Extended terminal covers, fitted with rubber grommets, are available for use with T.R.S. cable or conduit.

60 amp DP

CATALOGUE No. ET.60D

For use as consumers' main switch in small dwellings, especially in rural areas, and for protection of farm equipment and industrial small tools. Overload protection can be provided. Extended terminal covers, fitted with rubber grommets, are available for use with T.R.S. cable or conduit.

Pamphlet No. ST.2 gives details of AEI Monitored Earth Leakage Circuit Breaker Units for automatic switching off should the earth wires become disconnected or fractured.

15 amp DP 'Safetrip' Switch Socket

CATALOGUE No. EL.15

Suitable for 13/15 amp. 250 v. circuit; complete earth leakage protection for domestic apparatus using up to 3 kW. Available also as switch only.

15 amp DP

CATALOGUE No. ET.15D

15 amp DP with 13 amp socket

CATALOGUE No. EL.15/S

A compact unit giving earth leakage protection on sub circuits supplying domestic apparatus. Gives easy connections without use of extended terminal covers. Double enclosures are added protection against dust.

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Cable Division
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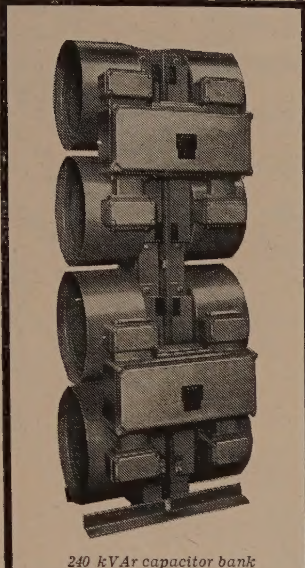
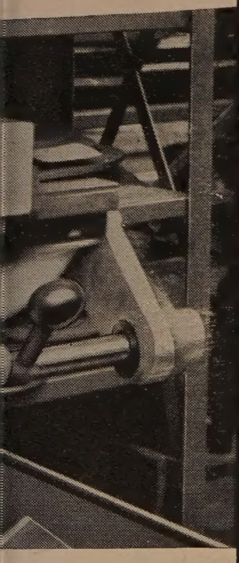
CAPACITORS . . .

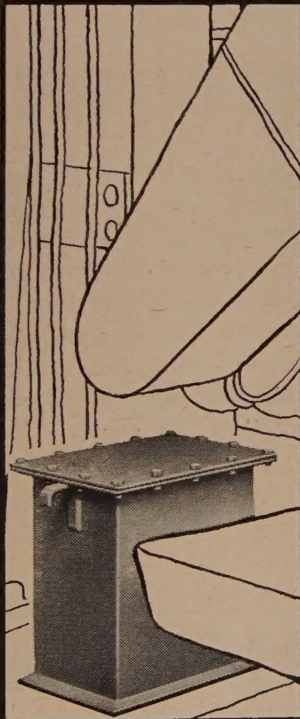
to cut the power costs of industry

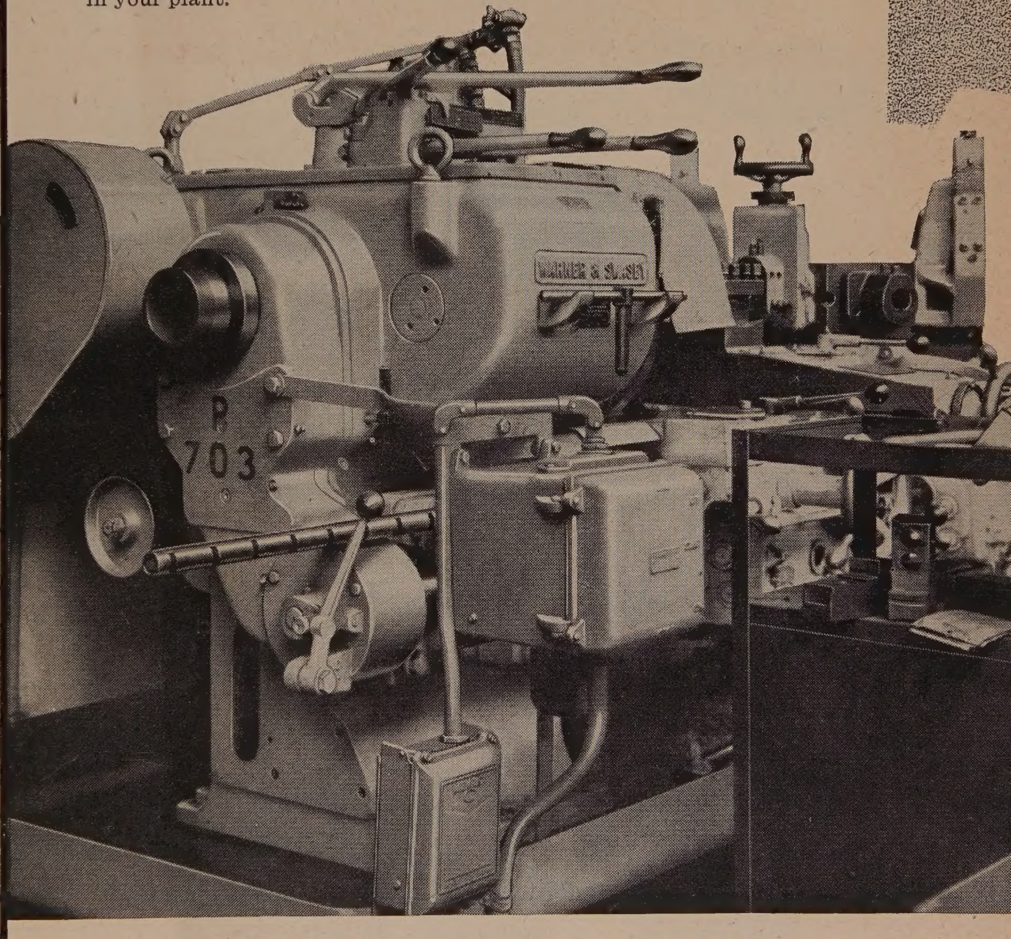

240 kVAr capacitor bank

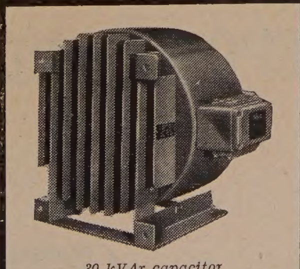
Check your electricity power bills. You may find that you are paying heavily for not correcting your power factor. ASEA capacitors provide the most reliable and effective way of ensuring, constantly, that the highest possible proportion of current consumed is converted into useful work. The capital outlay on installation of capacitors can be recovered in 12-18 months' operation. Efficiency exceeds 99.7 per cent. Installation costs are low. No maintenance is necessary. A minimum of space is required as shown by the illustration. Let us advise you, without obligation, on the installation of capacitors to correct the power factor losses in your plant.

ASEA








30 kVAr capacitor

consult FULLER ELECTRIC

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FULLER ELECTRIC LIMITED · FULBOURNE RD · LONDON E17

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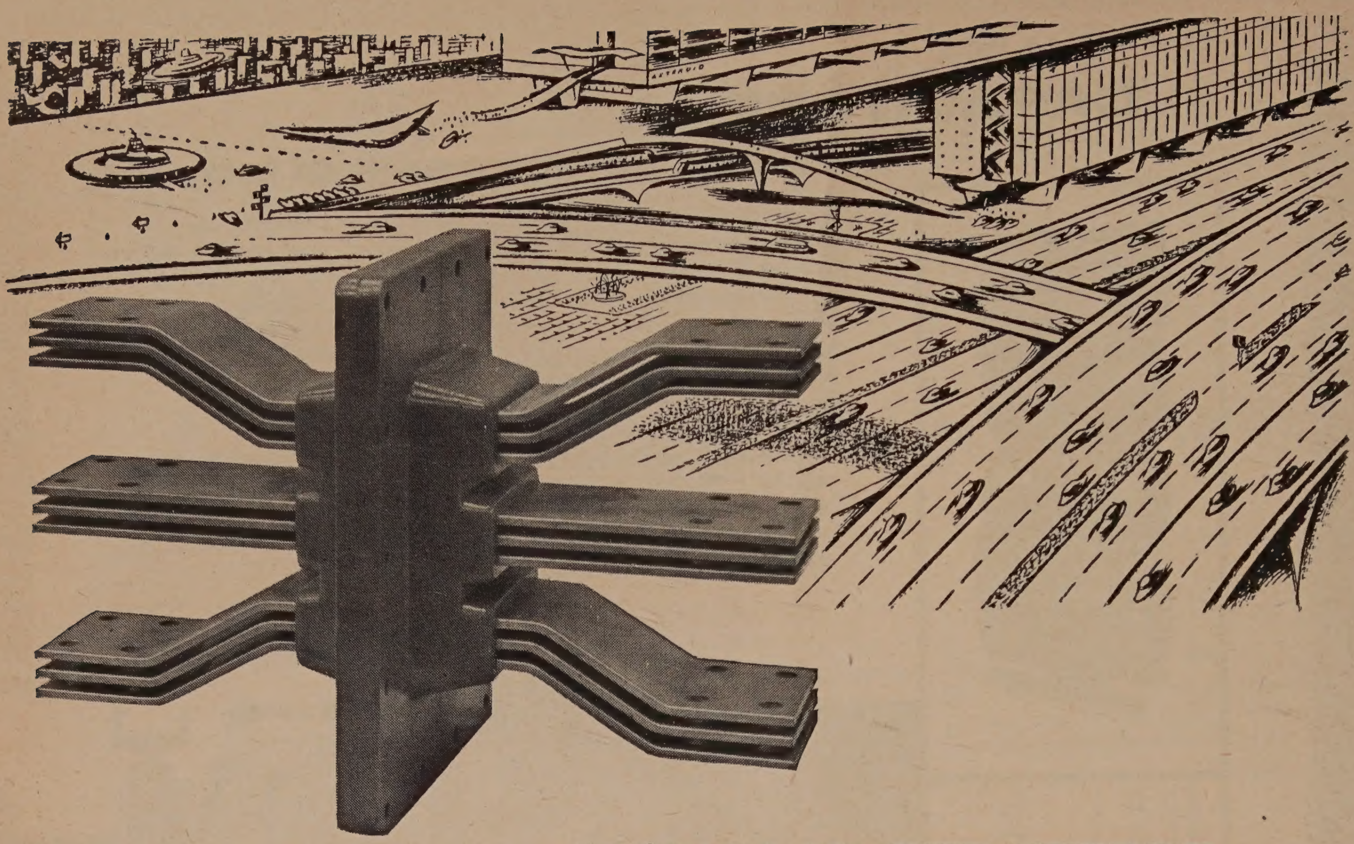
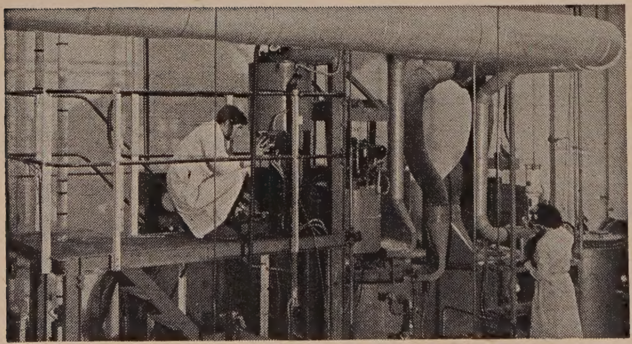


SERVICE OF THE FUTURE

Cast epoxide resin insulation has immense possibilities and many engineers are thinking of using it—some time in the future. The advantages of the material are, of course, well known and widely accepted, but there still remains the problem of the time and man-power needed to modify old designs and develop new ones. This is where we come in. Modern plant, complete tool design and manufacturing capacity and years of know-how in finding the right answers to difficult design problems—these all add up to smooth and economical Permcast production—whether "one-offs" or large quantities are required.
Why not get in touch with us?



Vacuum casting plant showing mixing chambers and autoclaves.

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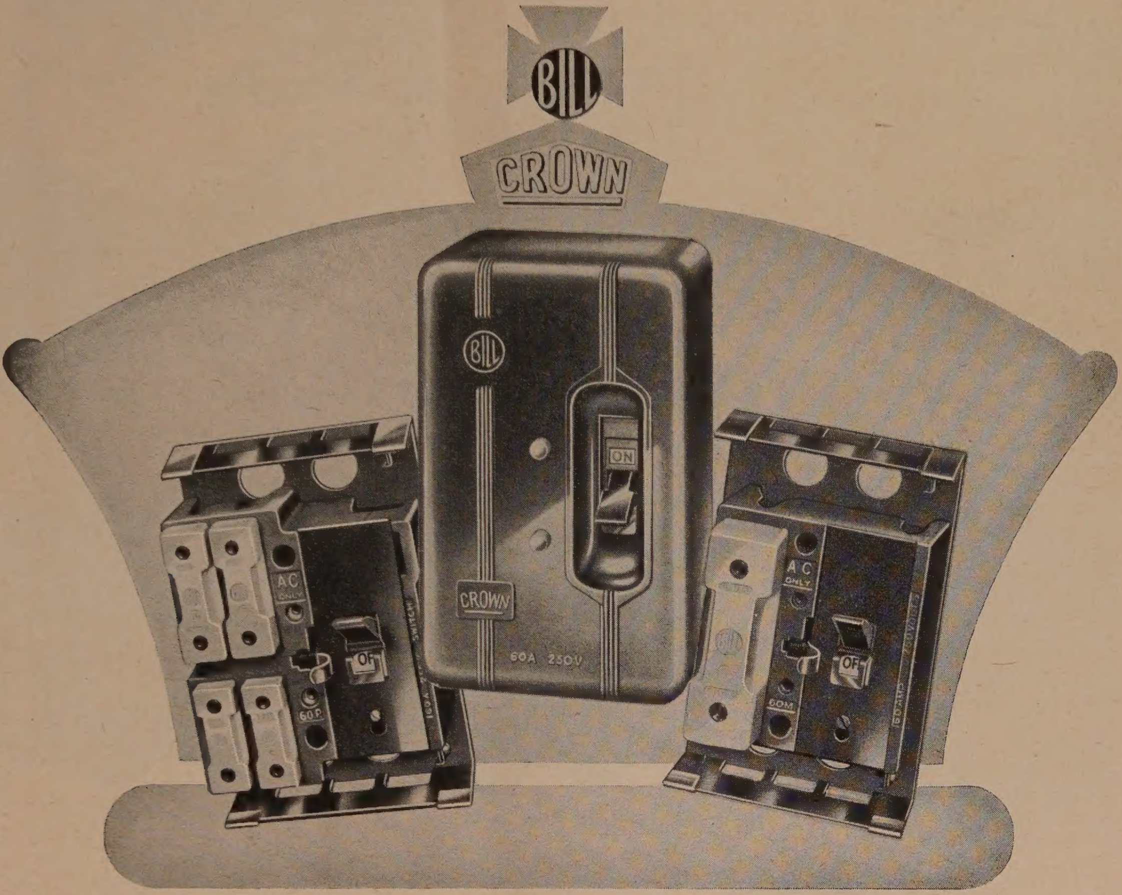

SWITCHFUSES AND SWITCH SPLITTERS

- A RANGE OF S.P. & N. MAIN SWITCHGEAR FOR MODERN DOMESTIC INSTALLATIONS.
- AVAILABLE IN 15, 21, 30, 34 AND 60 AMP. SWITCH RATINGS.
- SAFE AND RELIABLE SLOW-BREAK A.C. FRONT OPERATED SWITCHES.
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- VITREOUS PORCELAIN FUSES IN H.R.C. OR BILL ARC DAMPING TYPE.
- SEE THE FULL RANGE IN ILLUSTRATED PRICE LIST No. CR.656.

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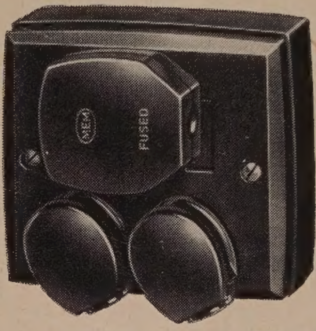
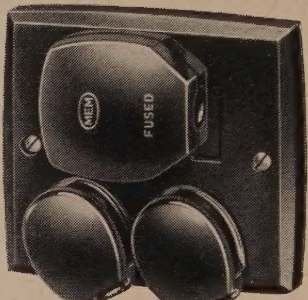
Electrical accessories from the MEM range

- Three outlets in one—yet only slightly larger than a single 13 amp. socket outlet.
- One 13 amp. 3-pin (flat) and two 2 amp. 3-pin (round) outlets, the latter being protected by a B.S. 646 cartridge fuse-link which can be replaced from front.
- Supplied complete with three plugs.
- Brown or ivory finish.
- Steel boxes with knockouts or spout entry.
- Flush pattern convertible to surface pattern by means of pattress.
- Backing plate to comply with I.E.E. regulation 207G.



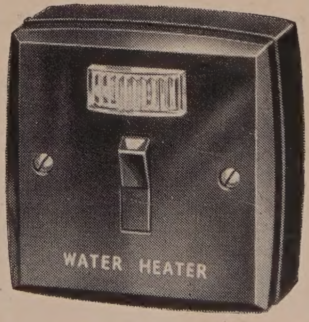
133 BOF with 133 PTB



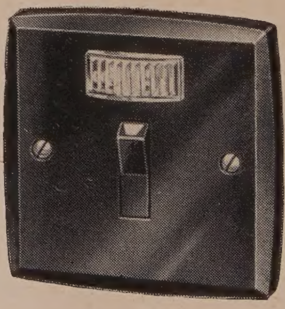
133 BOF

MEM triple socket outlet

- 20 amp. 250 volt D.P., A.C. only.
- Switches are of rocker dolly type.
- Neon pilot lamp visible over wide angle.
- All insulated. Suitable for direct mounting into B.S. 1299 box.
- Brown or ivory finish.
- Flush pattern convertible to surface pattern by means of pattress.
- Backing plate to comply with I.E.E. regulation 207G.
- The unit can be engraved "Water Heater" when required.



20 SBNF/WH with 12 PTB



20 SBNF

MEM water heater switch

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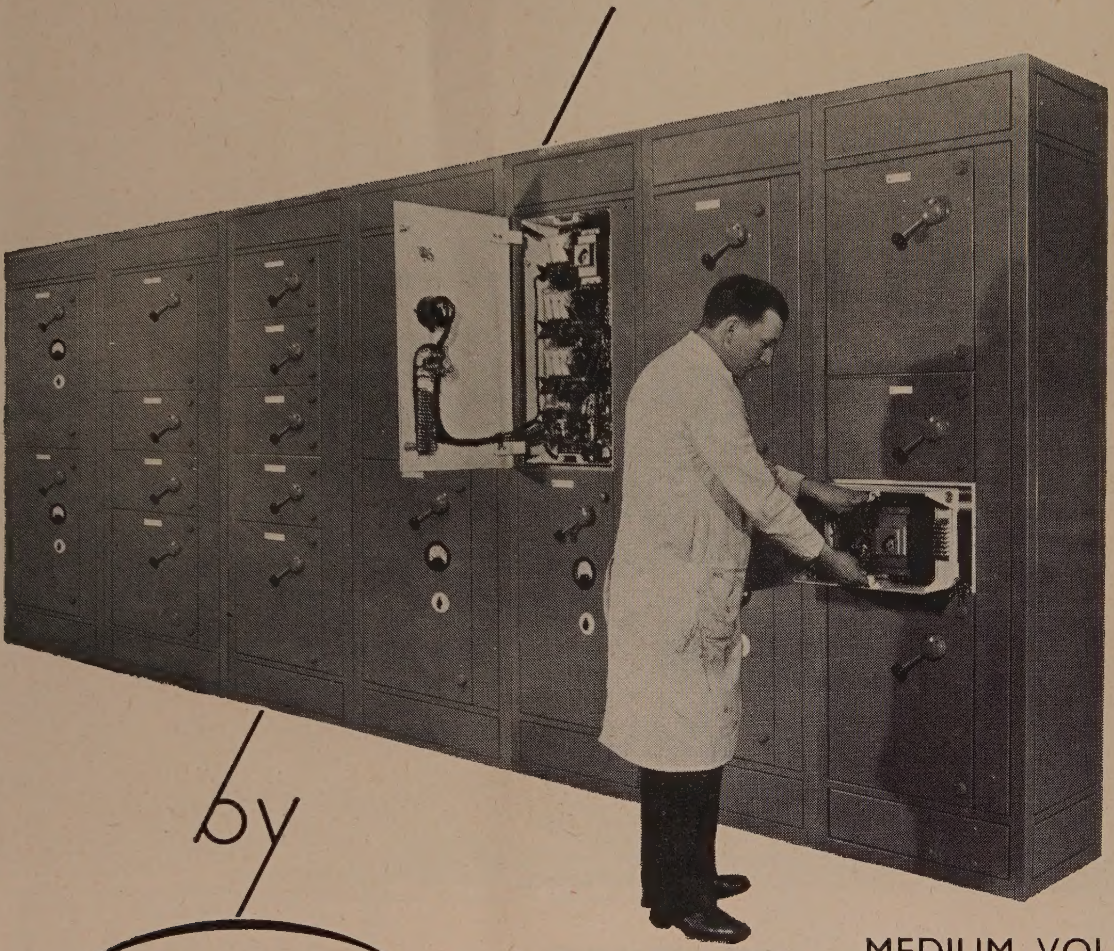
MOTOR CONTROL CENTRES



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MEDIUM VOLTAGE.
UP TO 100 h.p.

SOLVE YOUR GROUPED CONTROL PROBLEMS
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SIMPLIFY MAINTENANCE

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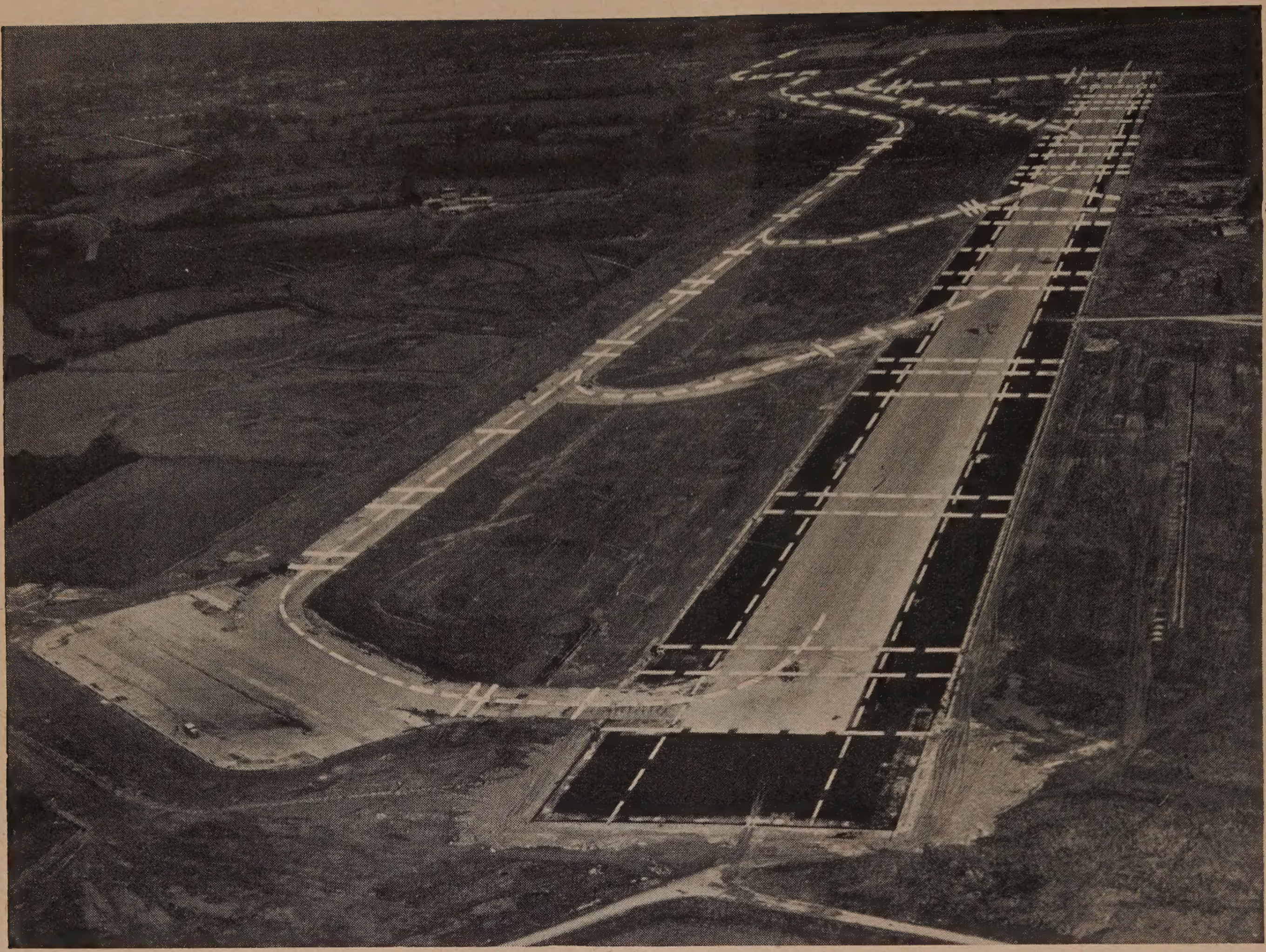

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Main Contractor: Sir Alfred MacAlpine & Son, Ltd.

37 MILES OF KEY PITCH FIBRE CONDUIT FOR GATWICK AIRPORT

A 200,000 ft. installation of KEY Pitch Fibre conduit at Gatwick Airport has brought considerable economies and consequent gains in efficiency. Running under the runways as indicated on the photograph by broken white lines, the outstanding resilience of KEY is a major advantage. KEY is the ideal conduit for cable protection; joints are perfect and the surface is smooth; it takes up the smallest space, requires the minimum of concrete surround and is the quickest and cheapest to install. This modern conduit system is used for runway lighting, radar and communication cables, sub-station power cables and many other services throughout the Airport.

Easier and cheaper laying 'Tap-in' joints give faster, all-weather laying. On cost plus labour basis, KEY Pitch Fibre conduit is cheaper per installed foot run than any other conduit system.
No cracking through settlement KEY Pitch Fibre conduit is resilient and even though foundation movement may occur, fracture of the conduit is most unlikely.
Highly resilient in service Will withstand all the exacting conditions of cable service.
Smooth bore — low friction A coefficient of friction as low as 0.30 facilitates cable pulling.
Light and easy to handle Transport, storage and handling costs are greatly reduced.
Sizes and fittings The standard length of light wall conduit is 5 ft. 6 in. for internal diameters of 2 in., 3 in., 3½ in., 4 in., 5 in. and 6 in. Where required, however, 4 in. and 6 in. diameter conduit can be supplied in 8 ft. lengths. Curved conduit, in 3 ft., 6 ft. and 12 ft. bend radii, is available in all diameters.
Fully approved KEY Pitch Fibre conduit is used by principal and local Government authorities both in the U.K. and overseas.

Get to know more about KEY PITCH FIBRE CONDUIT

The world's finest conduit at lowest installed cost!

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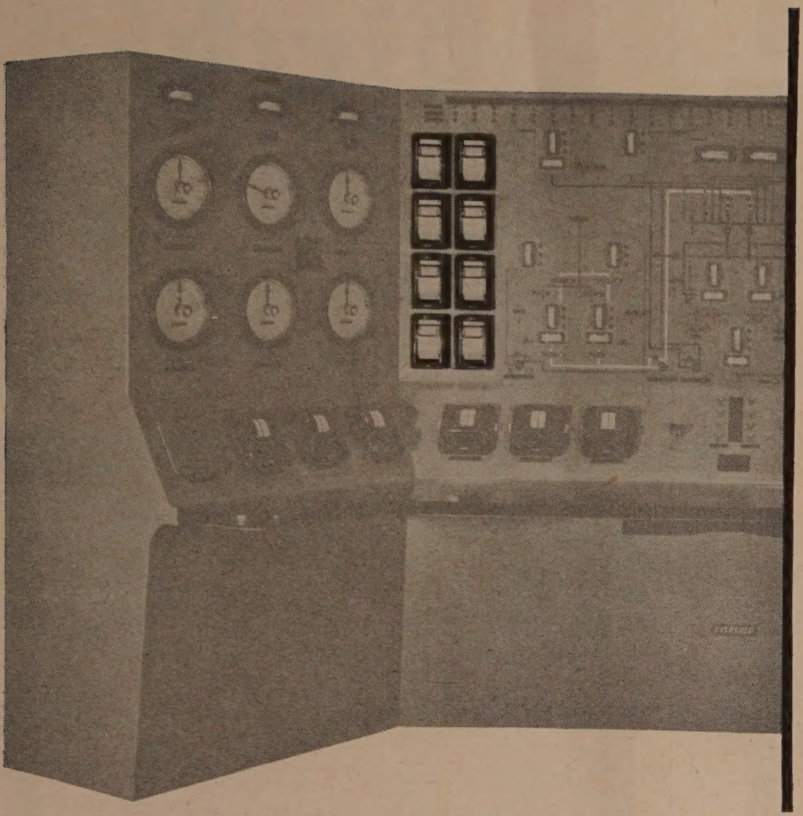

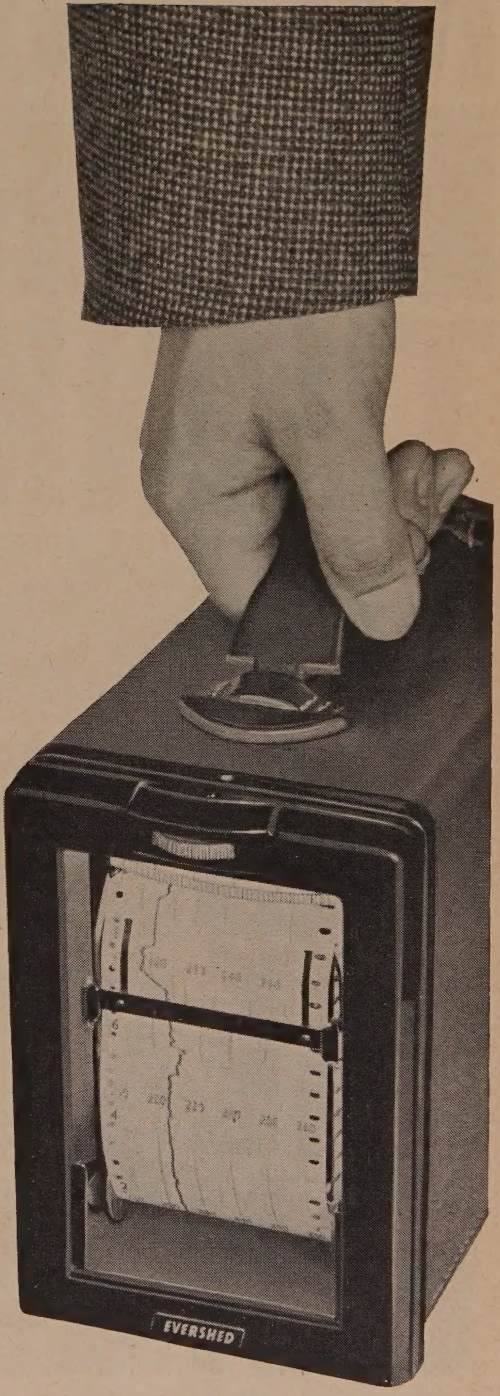

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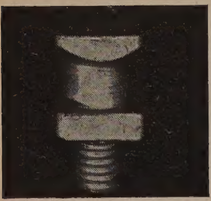

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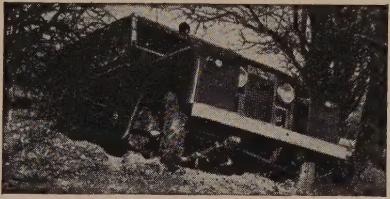
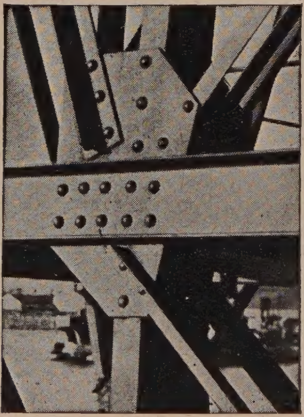


HOT GALVANIZING



**For further information write to
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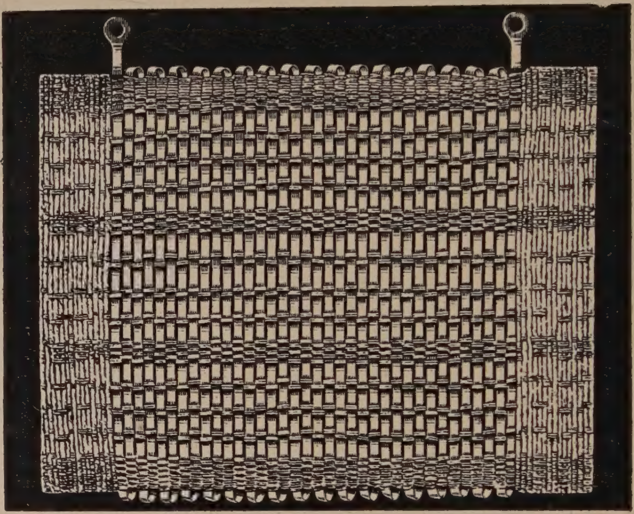

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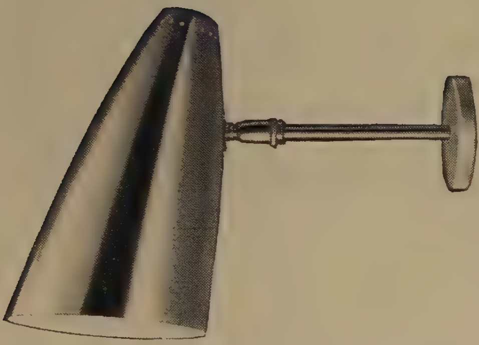
DISPLAY LIGHTING



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The complete new range is fully illustrated with technical details in Catalogue F4571. Please send for your copy.

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LIGHTING DIVISION

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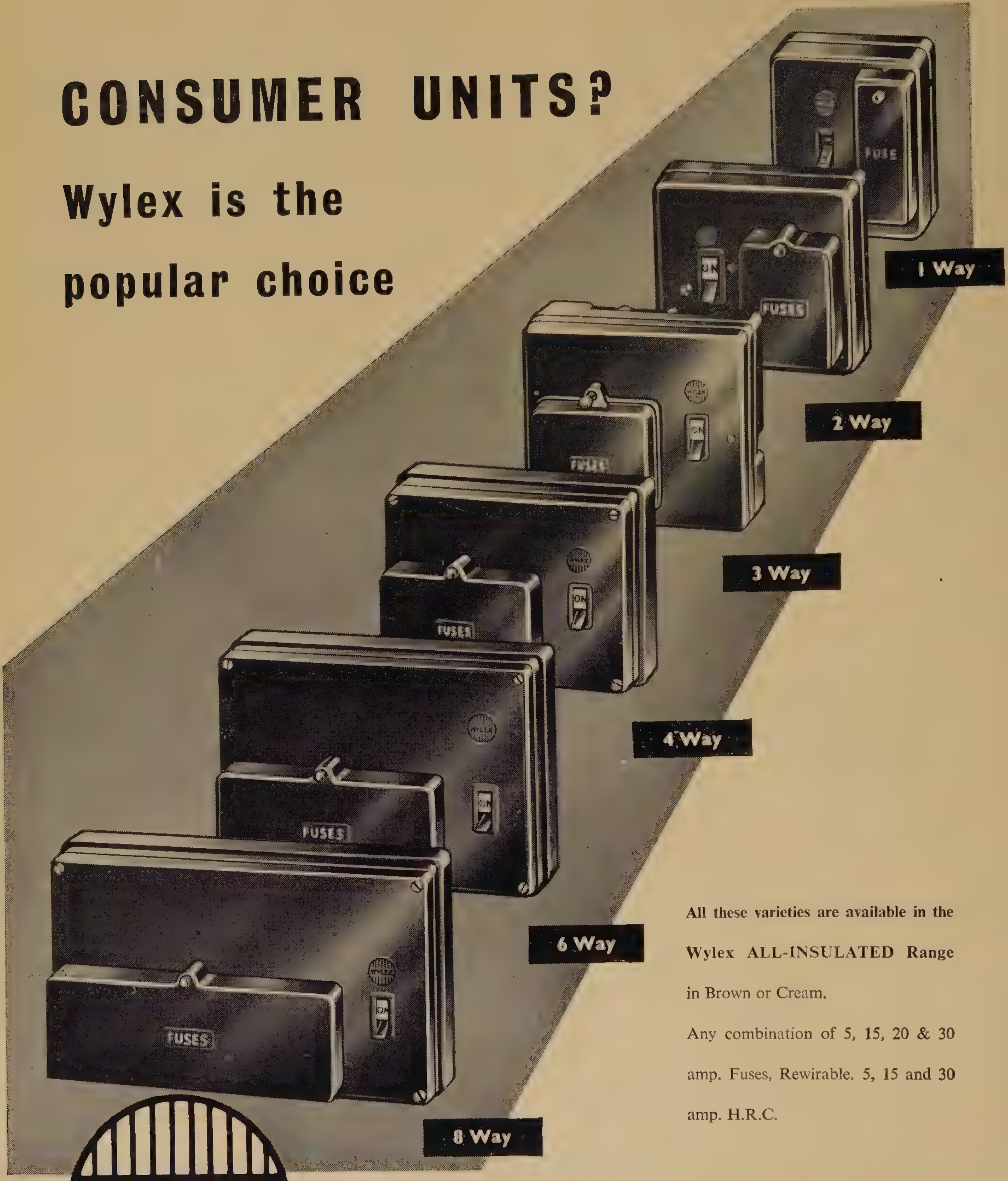

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Any combination of 5, 15, 20 & 30 amp. Fuses, Rewirable. 5, 15 and 30 amp. H.R.C.

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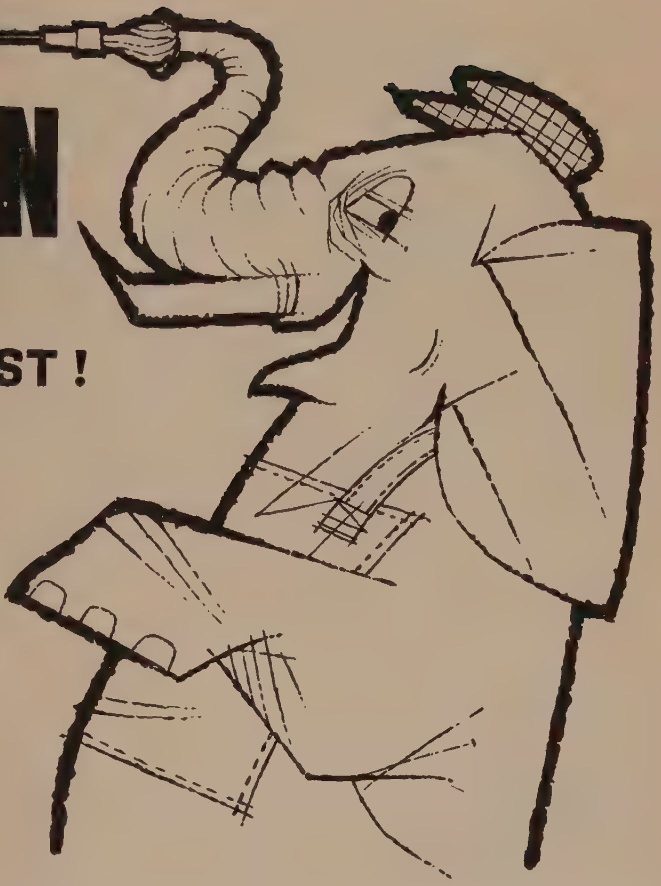

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A range of certified Intrinsically Safe equipment for use in gassy atmospheres, including hydrogen, is available. Also Pneumatic Electric Lamps for safe lighting in dangerous atmospheres, and Signalling and Sequence control for conveyors, etc.; Anemometers and Ventilation instruments.

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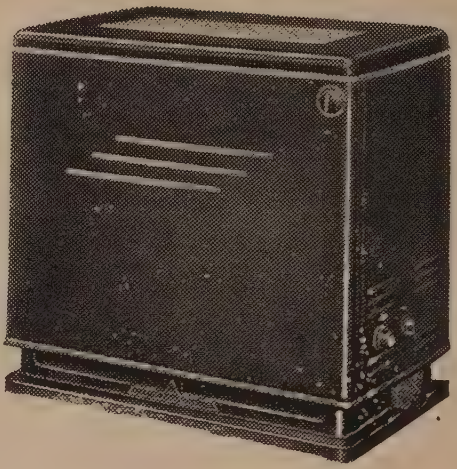
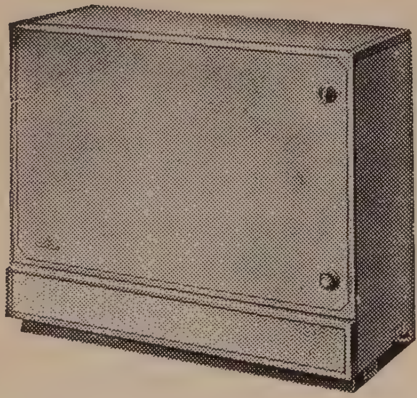


THE IDEAL HEATER

for schools, offices, restaurants and cafes, the modern heater with an elegant appearance and suitable colour according to choice in cream or bronze vitreous enamel.



NIGHT STORAGE HEATERS FOR CONTINUOUS OR SHORT PERIOD HEATING

Due to increased insulation, the heater for short period heating radiates less heat and because of the enlarged air channels the fan expels greater heat.

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The Core Thermostat with knob, bottom right-hand side, controls the current supply and therefore the storage core temperature is between 300 degrees C. and 600 degrees C. The switch is infinitely variable and it is therefore possible to obtain intermediate settings. By means of the core thermostat we can guarantee that the pre-set storage core temperature is reached.

The unit is charged at night by means of the cheap off-peak supply and delivers it according to requirements during the day. The heat radiation is effected by the fan which takes in the cool air. It is then heated in the storage container and expelled at floor level as hot air.

The room thermostat regulates the fan and the circulation of heat automatically. The insulating layer prevents premature heat radiation to the outside and is calculated in such a manner that a certain amount of heat is delivered through self radiation, therefore the room is never too hot or too cold.

Sole Concessionaires to the U.K.

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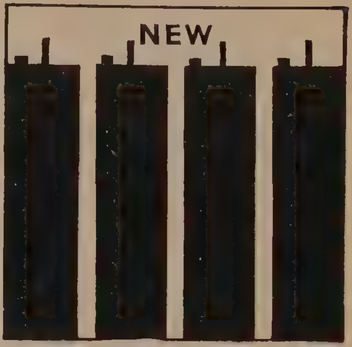
The ORMOND Engineering Co. Ltd.

★ *A new and important advance by Chloride Batteries Ltd*

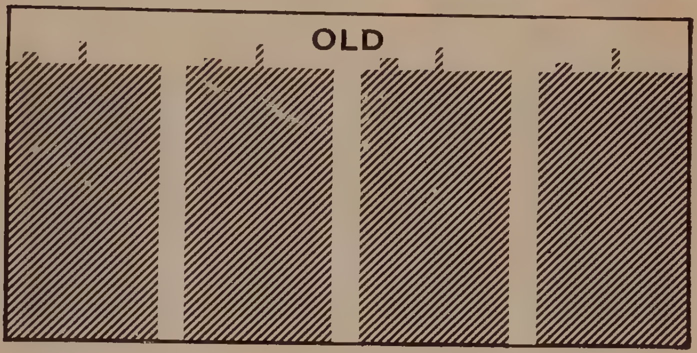
Stand-by power in half the space→

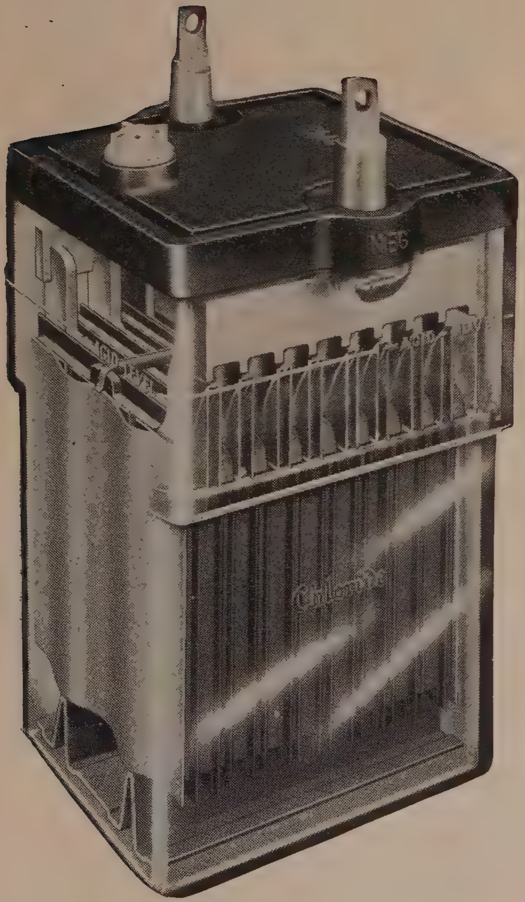


from the new

CHLORIDE

stationary cell





This new cell is specially designed for standby duties entailing discharge rates between, say, the 3-hour and the very high rates demanded for switch-closing purposes. With its Plante positive and pasted negative plates, Porvic microporous separators and many other improvements in material and in design, this light, robust cell will perform its duties with greater efficiency, with complete reliability and with a saving in battery space of approximately 50%. It is ideal for trickle-charge operation and has all the remarkable length of life associated with the Plante type of construction.

The field in which the new cell is designed to replace current Plante types is a very wide one. Emergency lighting*, switch operation and emergency supply in hospitals, theatres, cinemas and other public buildings, both nuclear and conventional power stations, all rely on trickle-charged batteries. In Great Britain today such batteries occupy millions of cubic feet of valuable space. The new Chloride cell could free almost half of it.

* *The new cell will from now onwards be fitted in all Keepalite units —the Chloride Company's automatic emergency lighting system.*

By the makers of Exide Batteries

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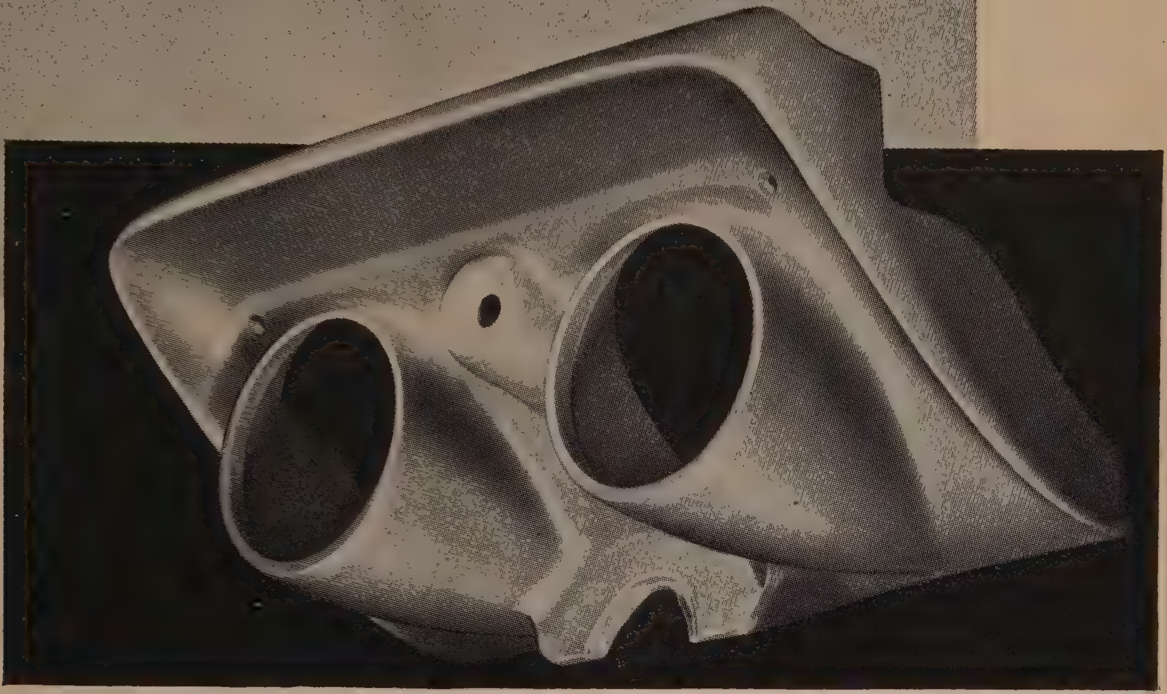
HARPER CAST DIES

overcame this pressing problem with a handsome margin to spare!



British Moulded Plastics Ltd. had to be in production within 12 weeks on this instrument housing for the Ford Motor Company. The job necessitated a single cavity compression mould—normal steel tools cut from solid forgings would take 18/20 weeks to produce . . .

. . . so Harper Cast Dies were ordered for the interim tooling and were ready in 6 weeks; tools were available for sampling within the scheduled 12 weeks! Of two Harper dies tooled in September 1957 one was still in production in mid-July 1959. The total number of mouldings pressed was then 121,030, the greater percentage of these by the tool still in use.

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The word MEEHANITE is a registered trade mark.

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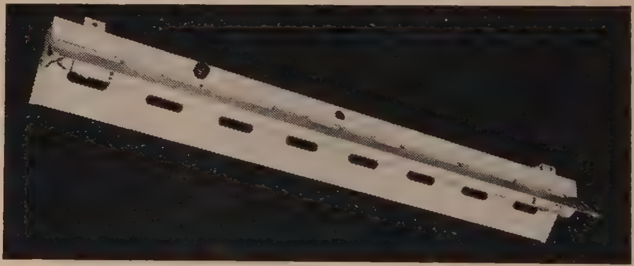
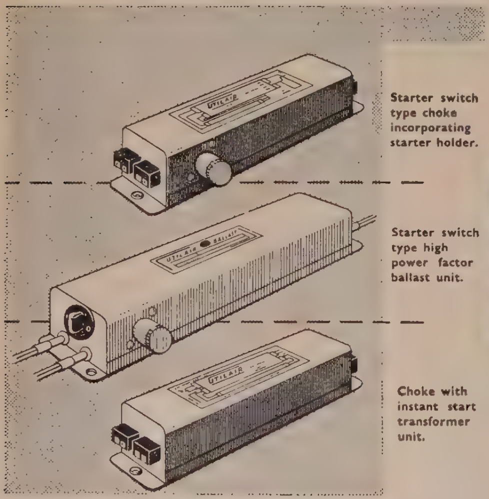


Model SSV.80 Industrial metal trough—slotted top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Starter switch type high power factor ballast unit.
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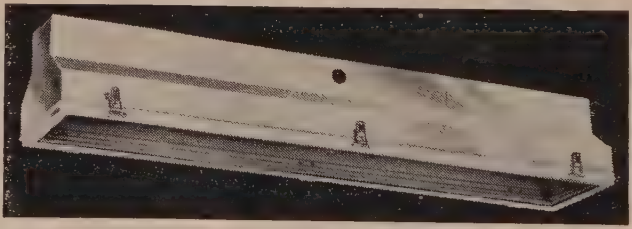

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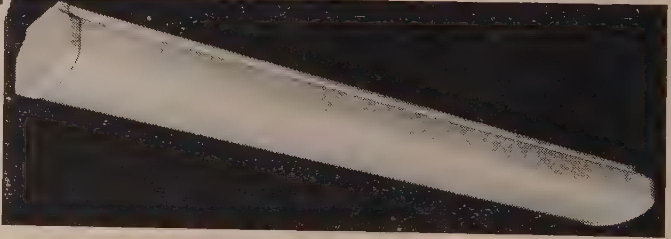

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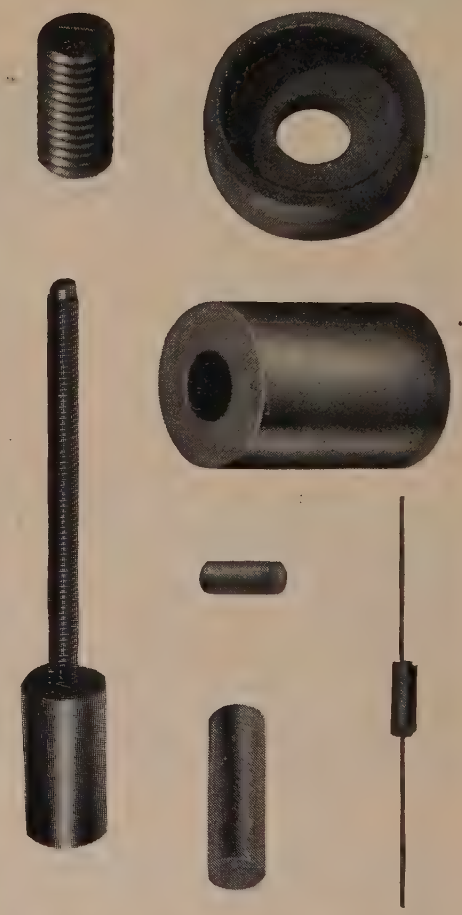

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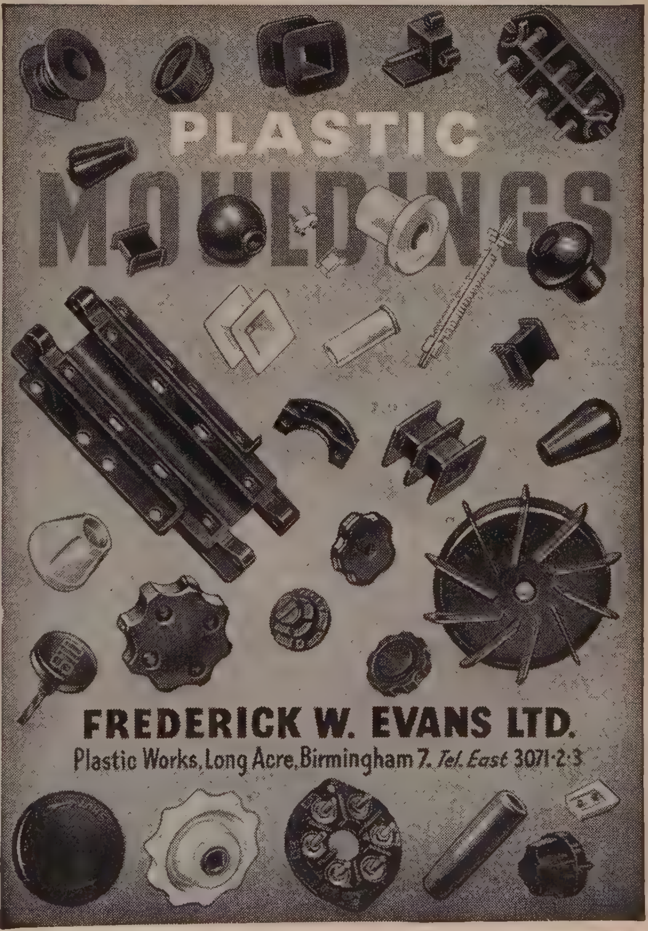
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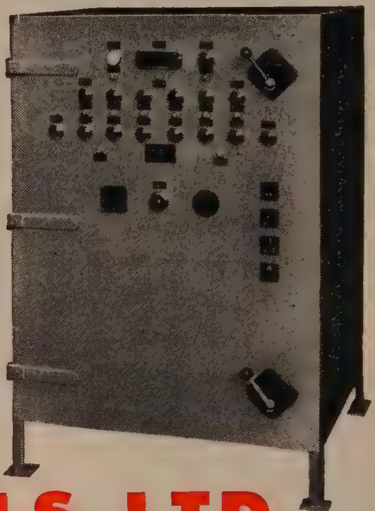

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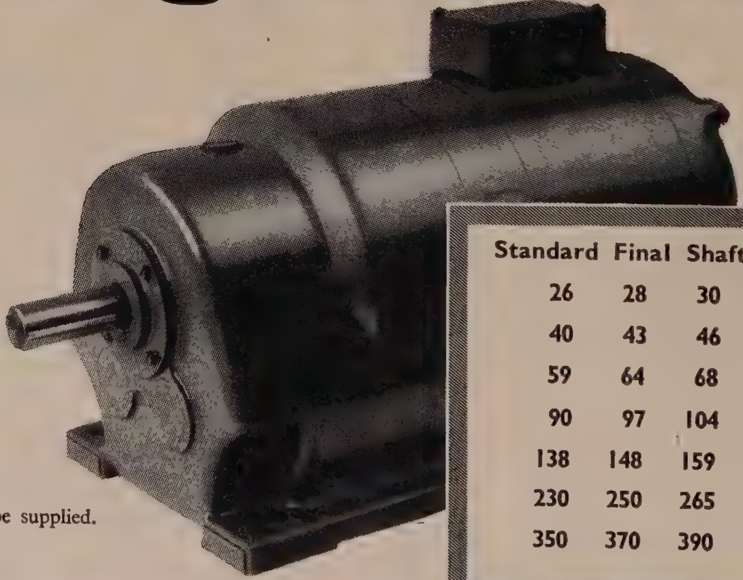

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90	97	104	112	120	128
138	148	159	170	200	215
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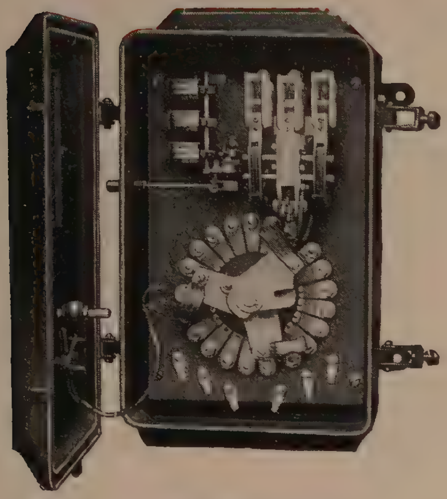

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30 h.p. 400/440 volts, 3-phase, 50 cycles A.C.

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All starters are available with or without isolators and with either magnetic or thermal overload relays as preferred.

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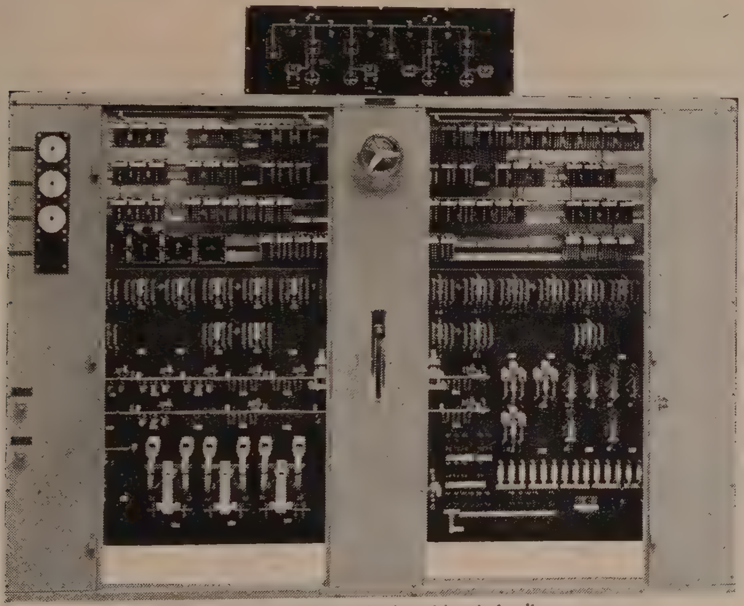

A multi-motor control cubicle with mimic diagram
for automatic control of a printing press

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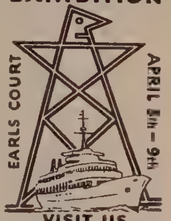

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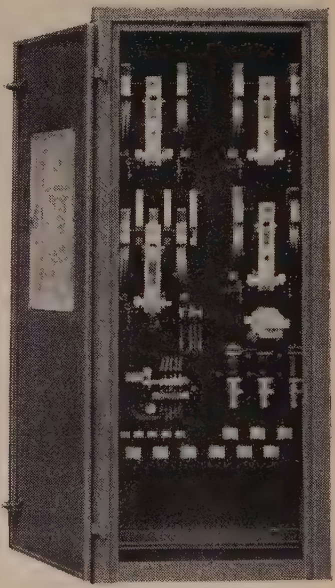

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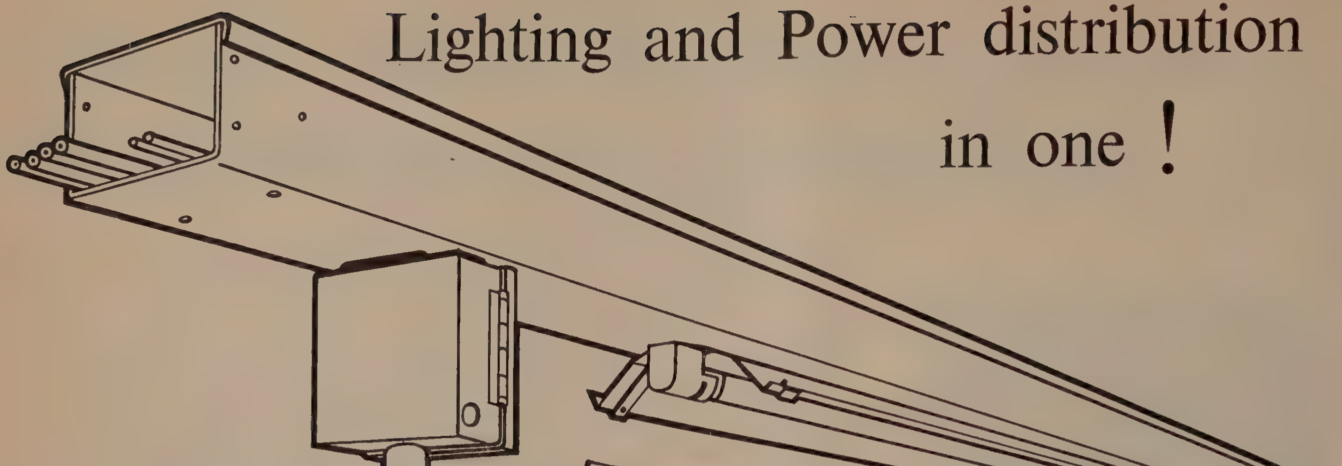

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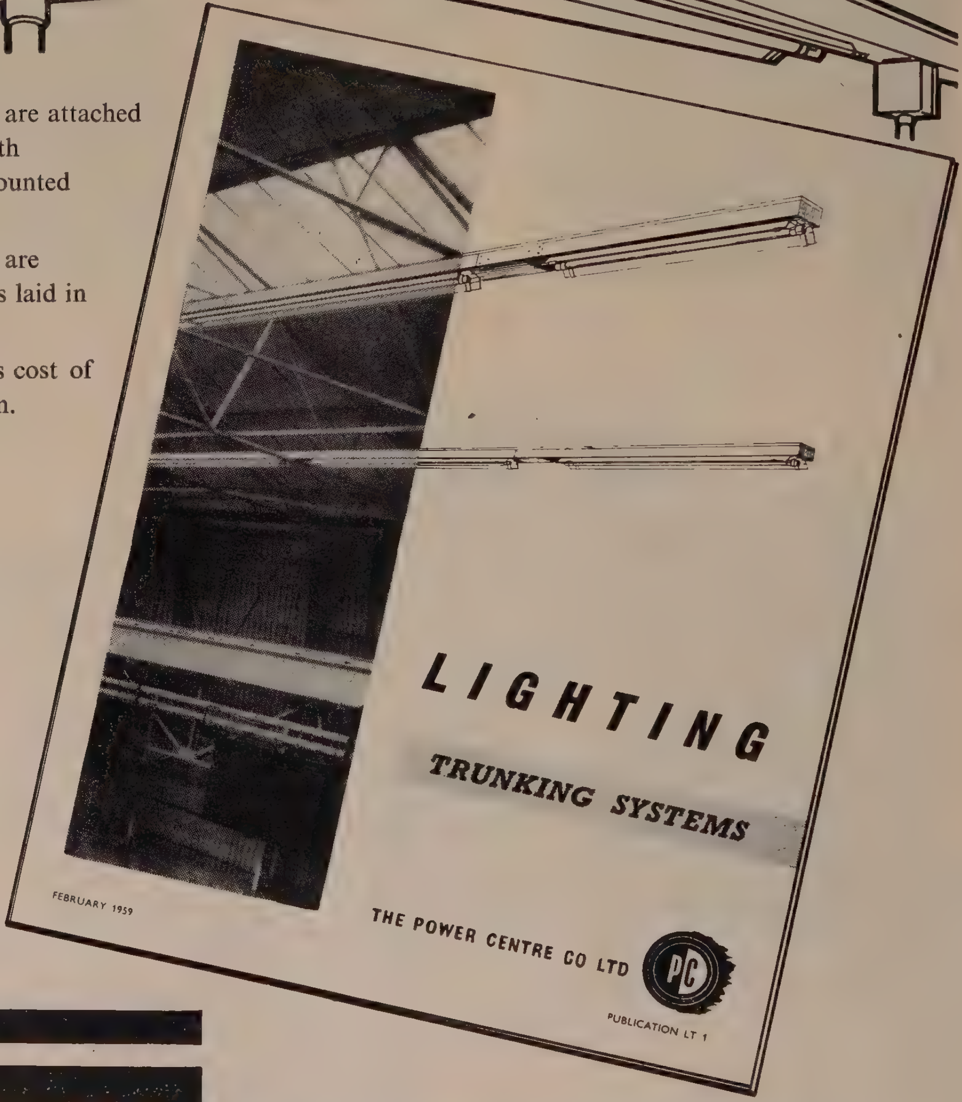

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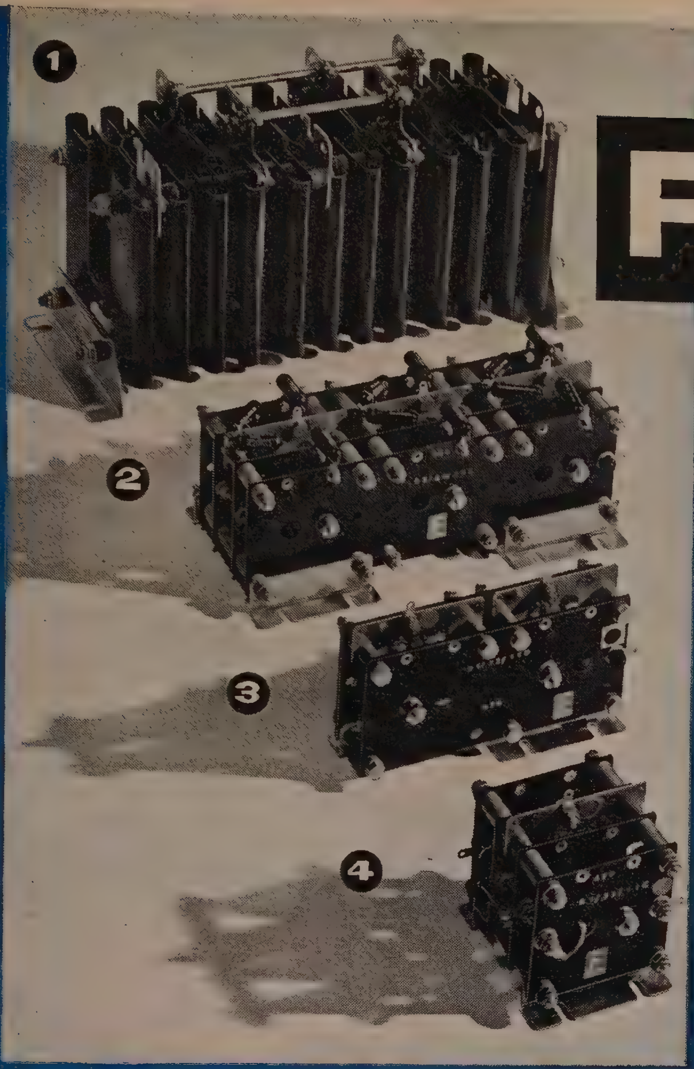

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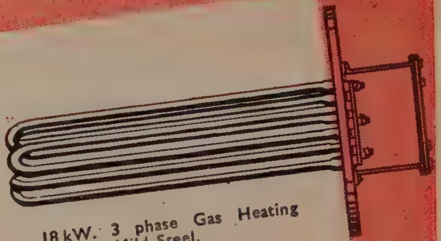

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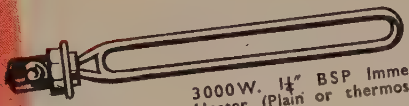

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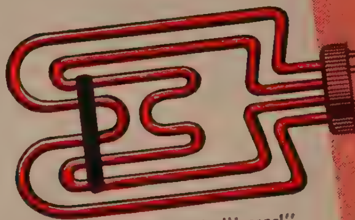
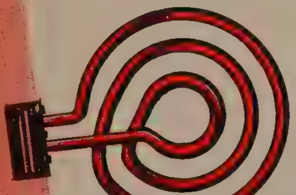
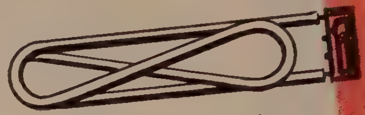


2500W. Grill Element in "Inconel"



2000W. Radiant Hood Heater for Circular Platen.



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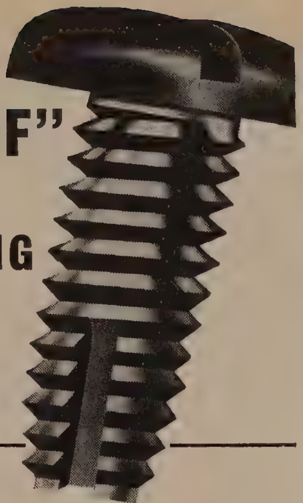

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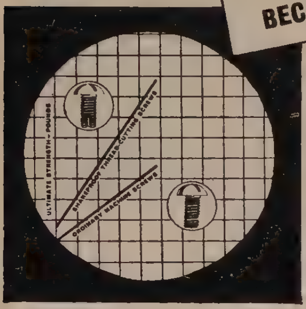

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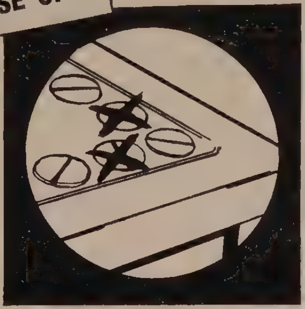

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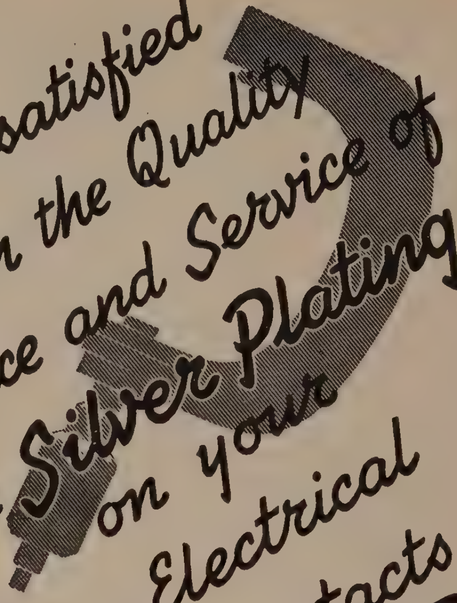

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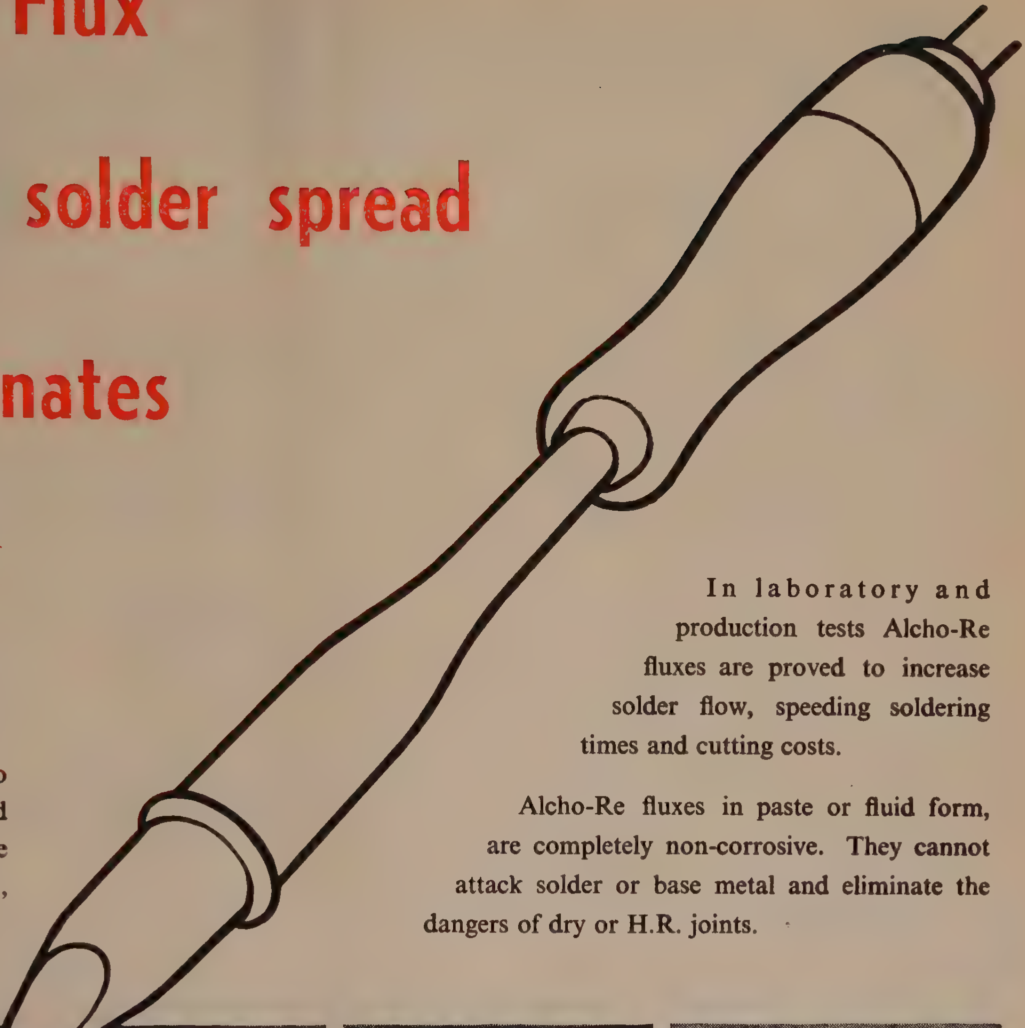
R 2

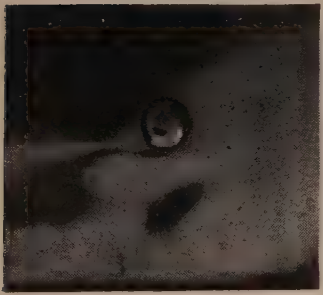
Alcho-Re Flux promotes solder spread and eliminates corrosion



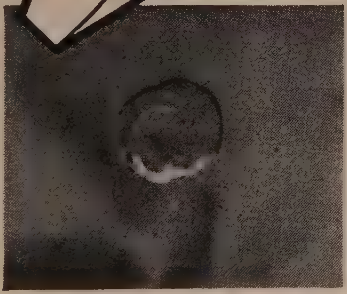
In laboratory and production tests Alcho-Re fluxes are proved to increase solder flow, speeding soldering times and cutting costs.

Alcho-Re fluxes conform to specification D.T.D.599 and R.C.S.1000 and are approved by A.I.D., C.I.A., I.F.V., D.C.I. and G.P.O.

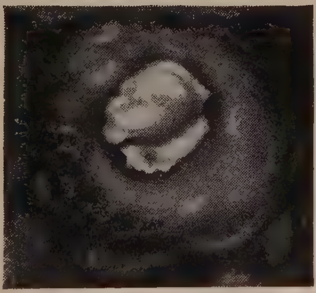
Alcho-Re fluxes in paste or fluid form, are completely non-corrosive. They cannot attack solder or base metal and eliminate the dangers of dry or H.R. joints.



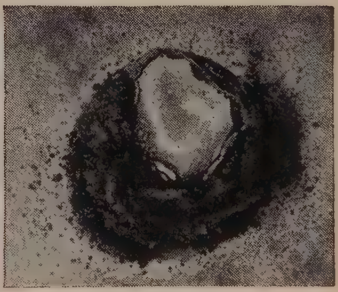
Plain resin flux restricting solder flow.



SOLDER *spread*
is increased with the positive fluxing action of ALCHO-RE.



ELIMINATES CORROSION
note the completely inert Alcho-Re residue after 3 months storage.



DANGEROUS CORROSION
The residue from an active flux caused this corrosion after only 3 days.

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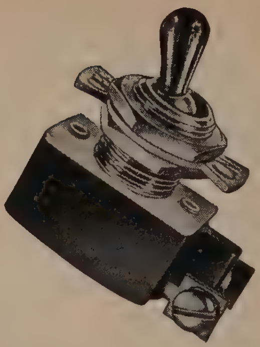
Switches

Neon Signal Lamps


G.600

S.L.160, S.L.162 and S.L.163

New miniature low cost Neon Signal Lamps.

½" hole fixing. All completely waterproof.

The S.L.163 has small front of panel projection.

C.S.200: 15-AMP Rotary Cooker Switch.

Double pole three "heat" and "off."

S.L.50: Neon Signal Lamp with snap-in fixing.

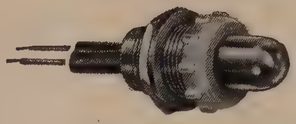
M.30: 10-AMP Toggle Switch.

A.55: Refrigerator Door Switch.

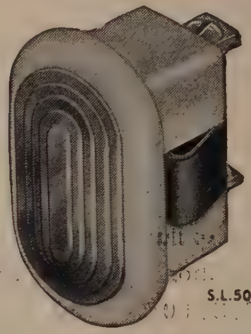
S.254: A.C. only 10-amp Toggle Switch, double pole.

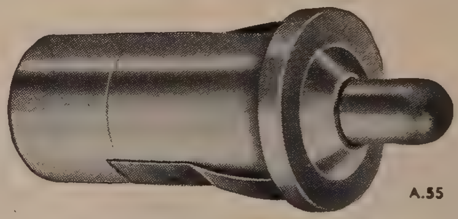
S.250: A single pole version of the S.254.

G.600: 3-AMP Toggle Switch.


S.L.160

S.L.162


S.L.50


A.55

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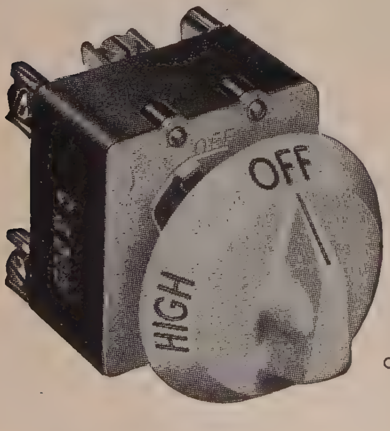
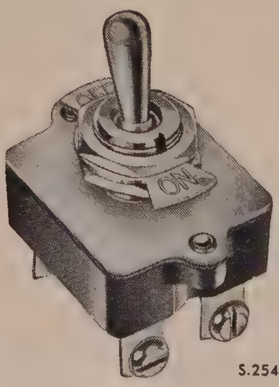
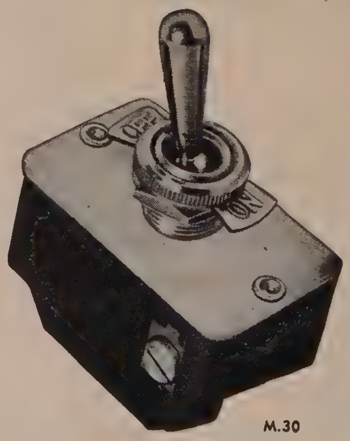


C.S.200



S.254



M.30

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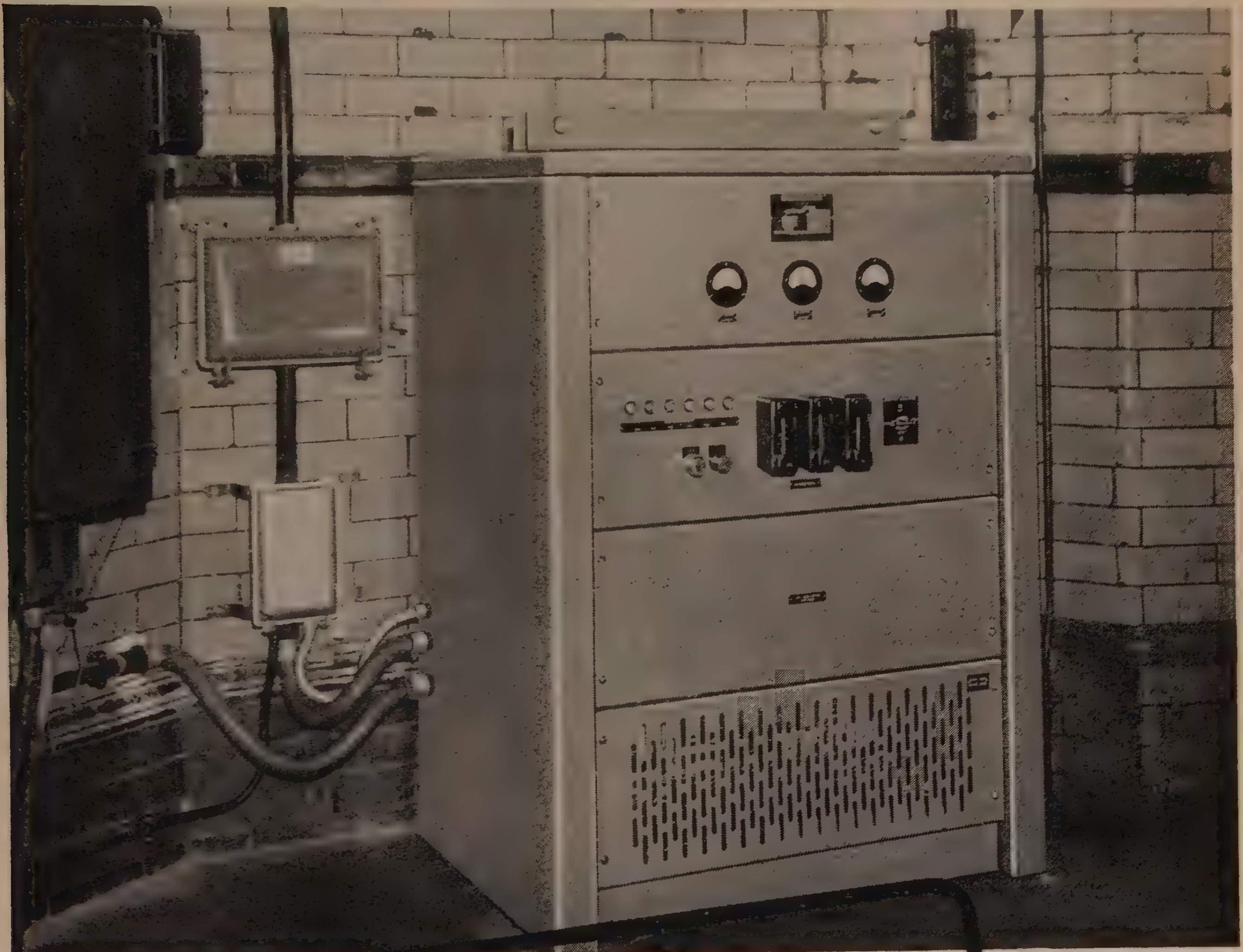

Another Rectifier installation by WESTINGHOUSE

This 35kW Westinghouse germanium rectifier equipment was installed by The North Western Electricity Board, No. 2 Sub-Area, at their Spa Road Depot, Bolton, to provide d.c. power to motors of an overhead travelling crane.

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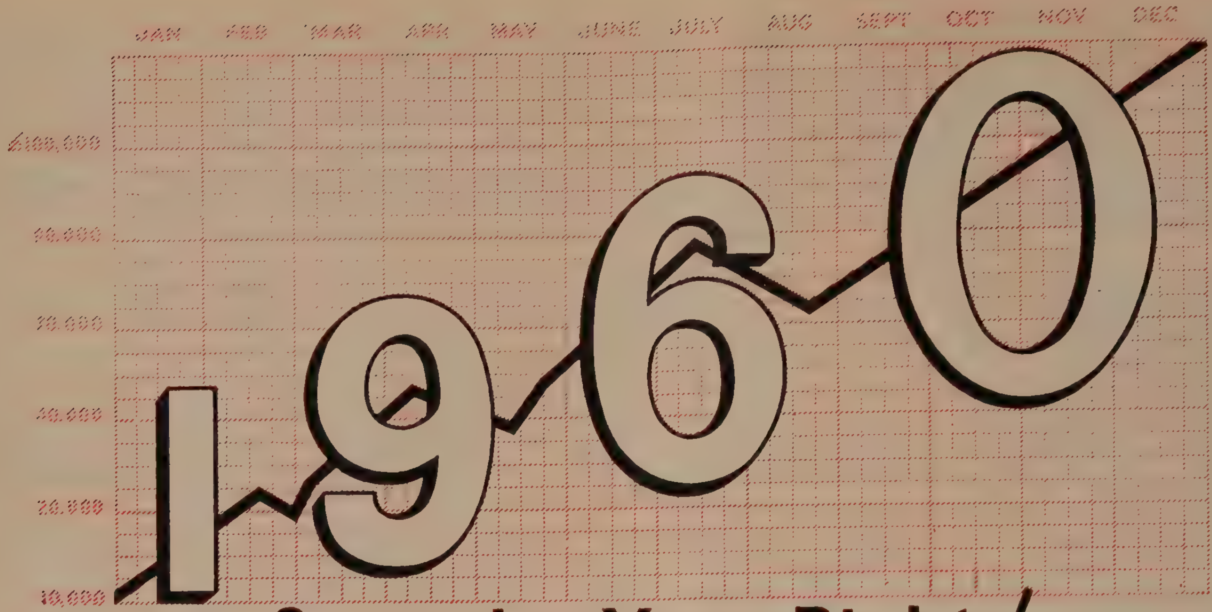

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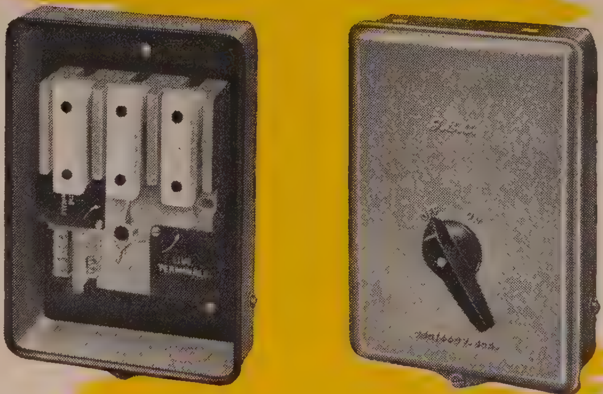

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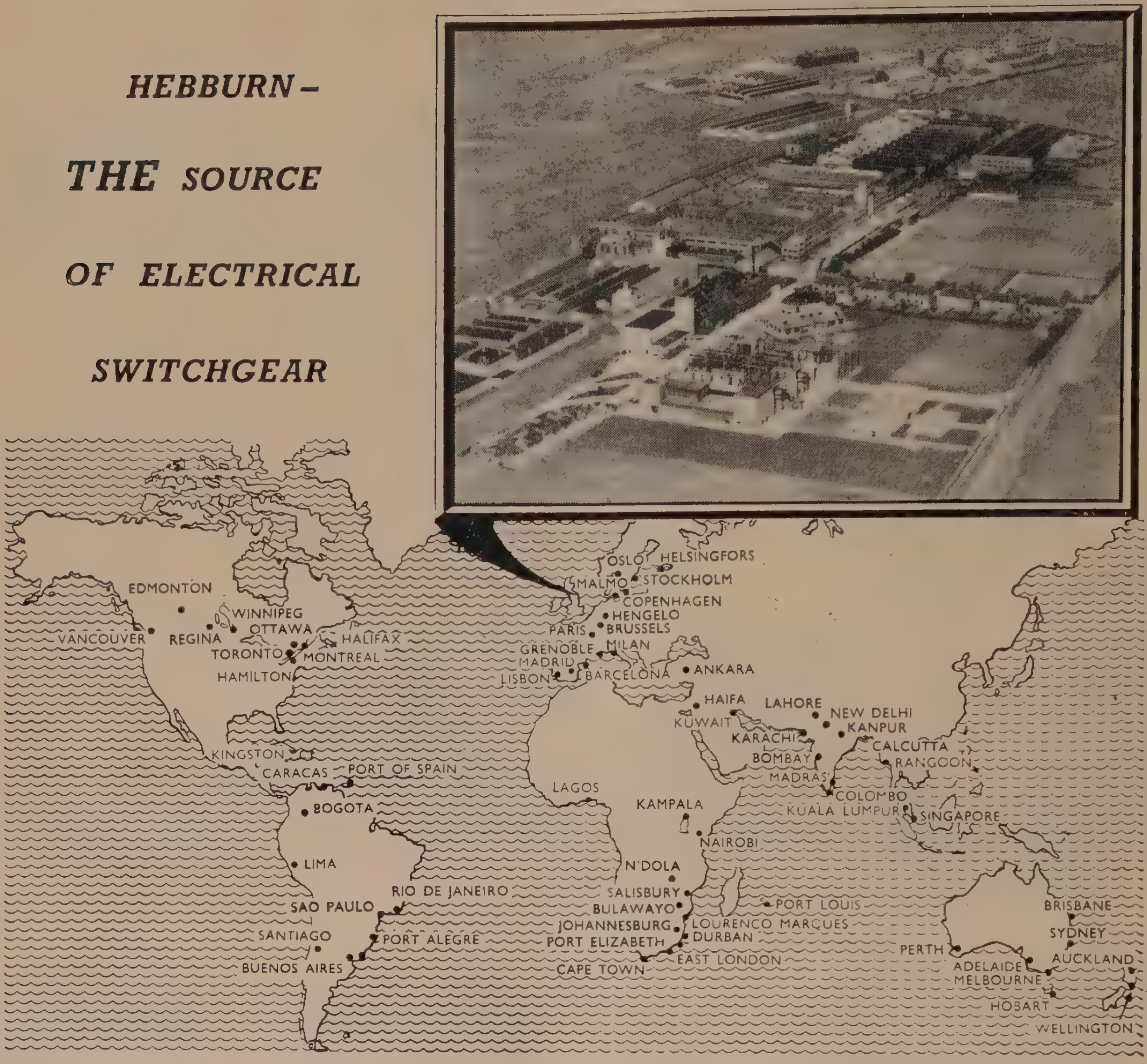

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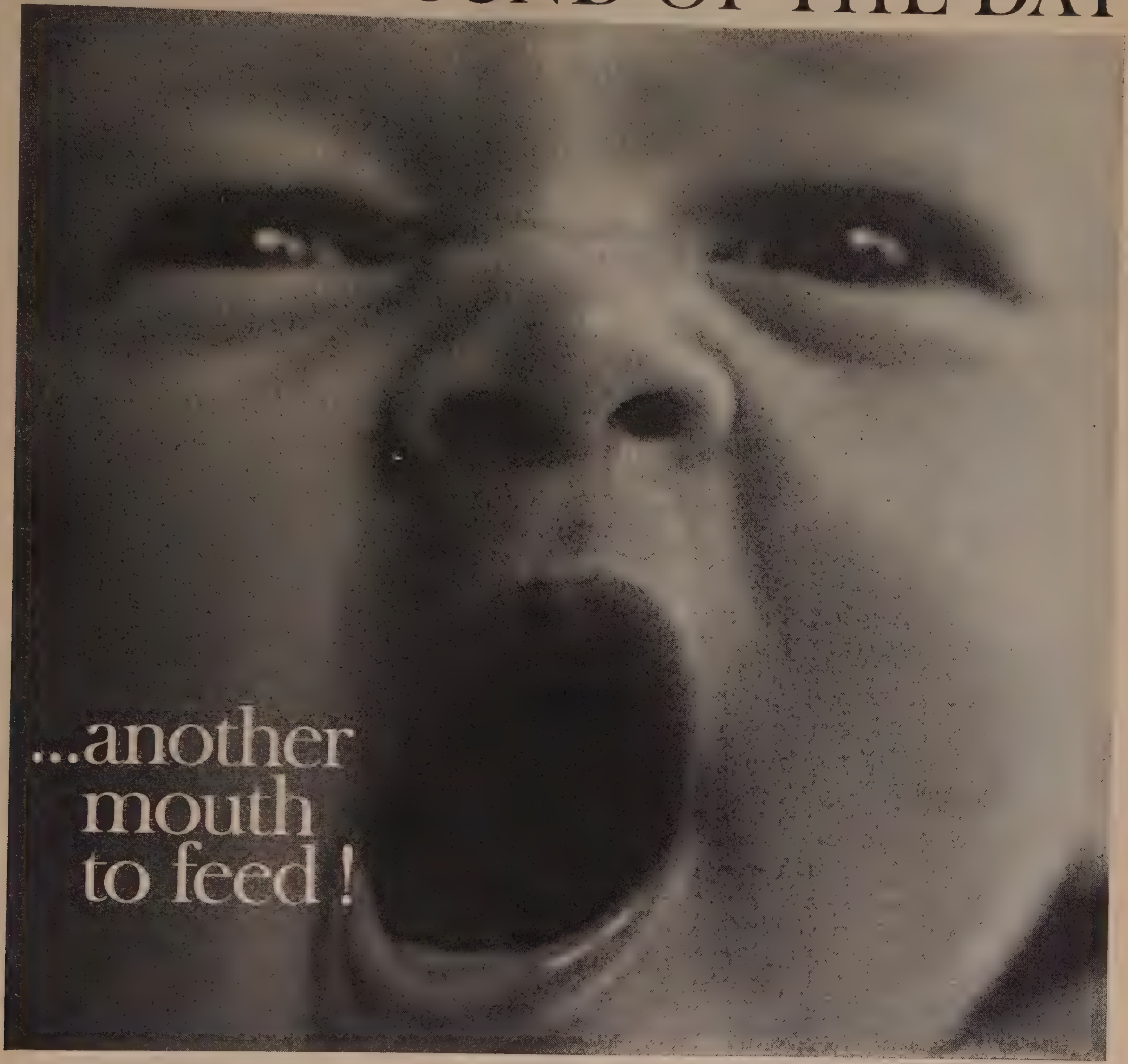

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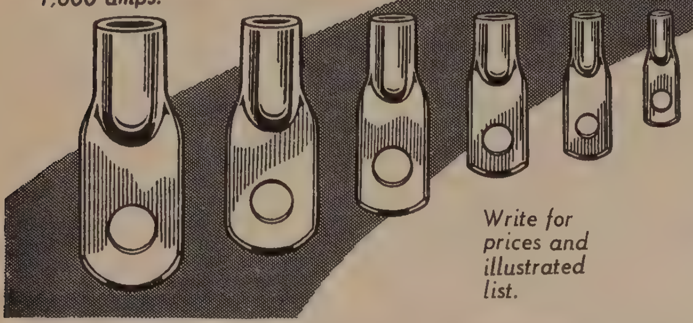
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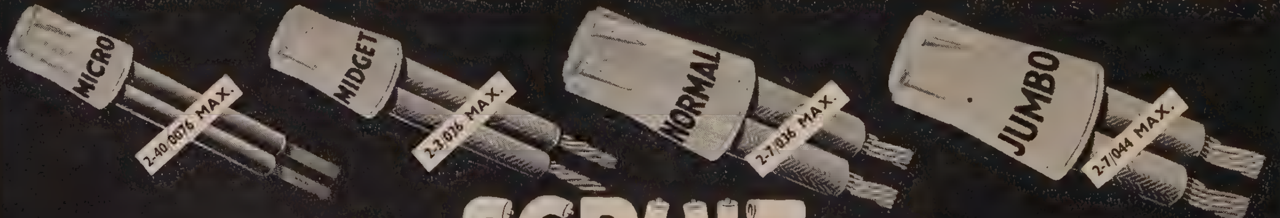
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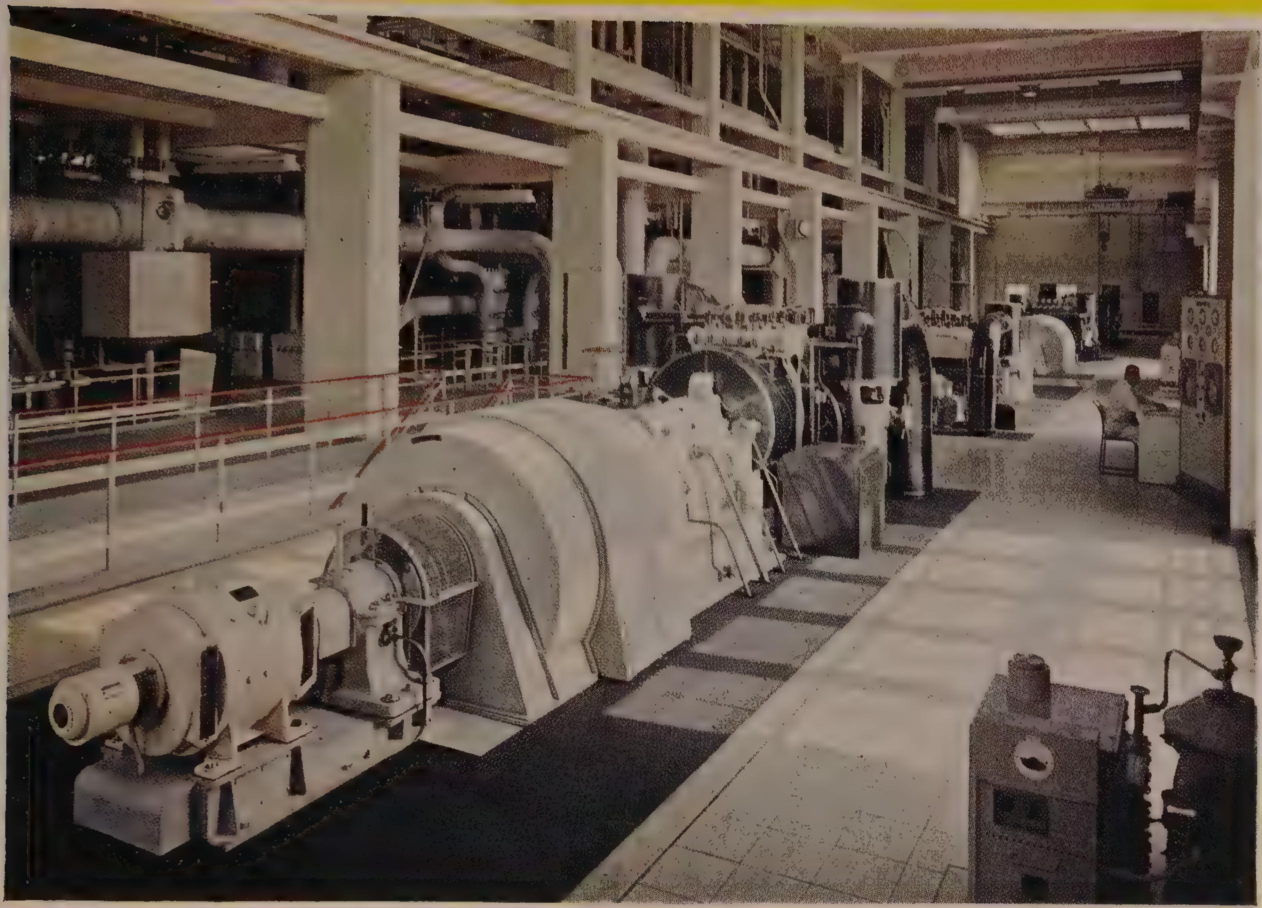

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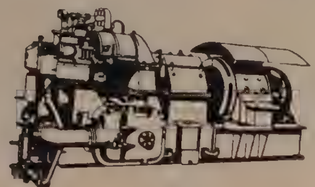

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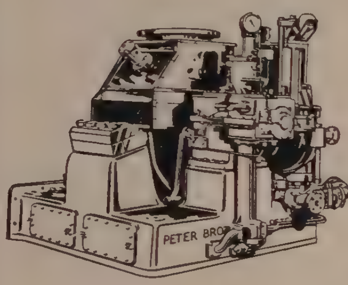

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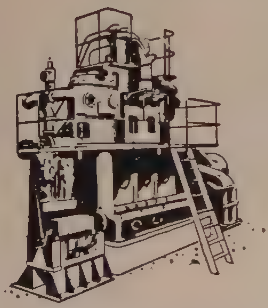

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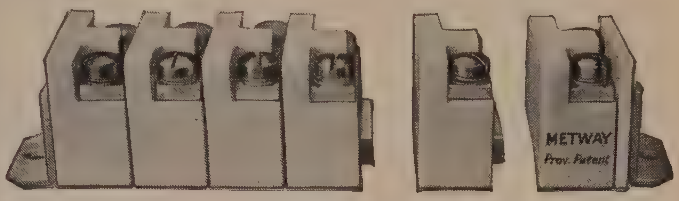

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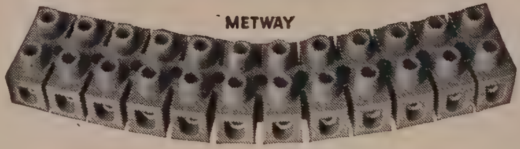
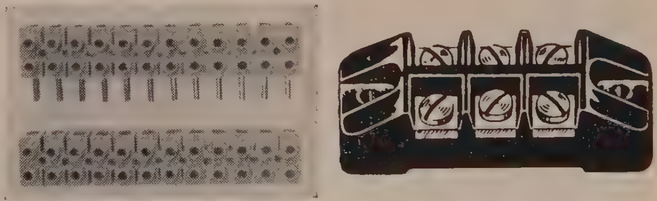
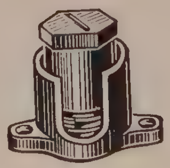


"POLYWAY" and "RUBBERWAY"





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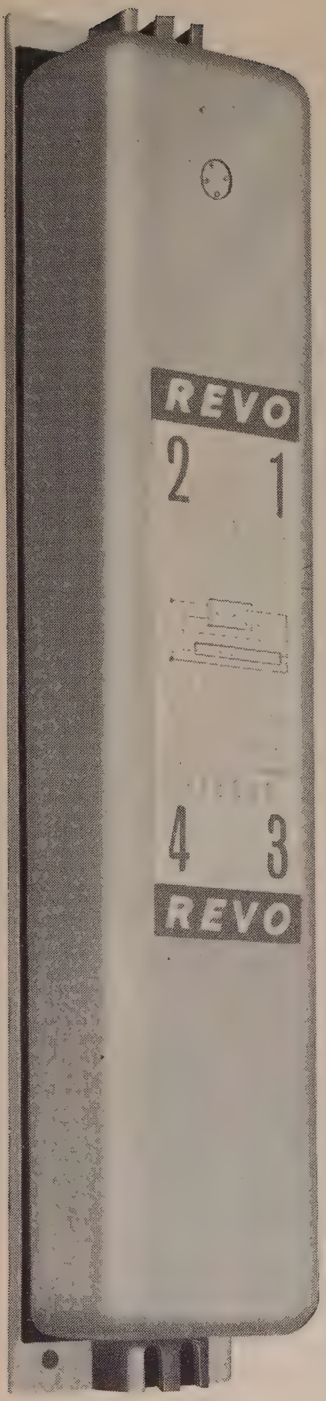

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Illustration shows (left) 80W. Unit. Cat. No. T15628

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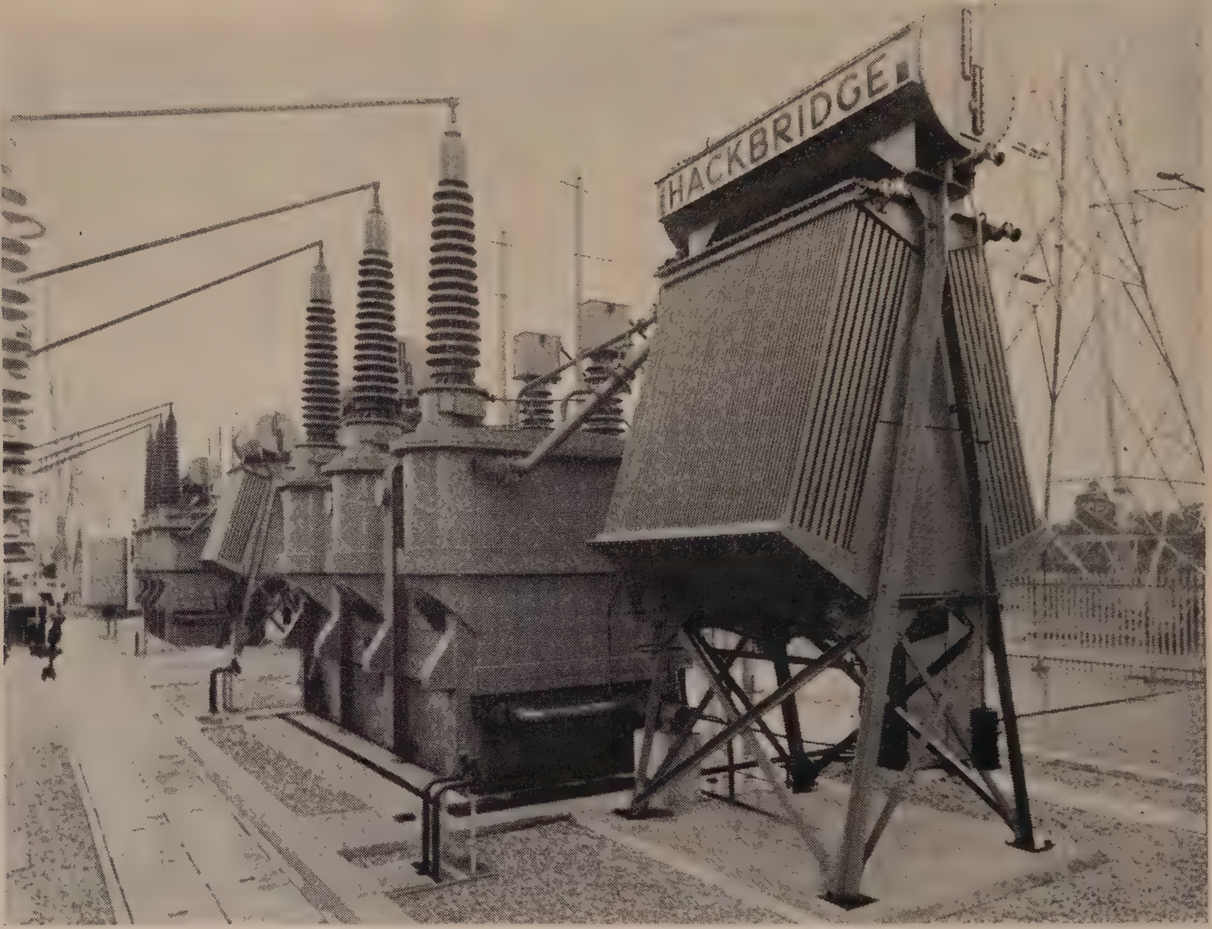

120 MVA

The illustration shows two 120 MVA 275/132 kV Hackbridge transformers installed at West Weybridge substation, Central Electricity Generating Board. A further similar unit is installed at Fleet whilst another is in course of manufacture.

180 MVA

Instructions have now been received from the Central Electricity Generating Board for the manufacture of four 180 MVA 275/132 kV Hackbridge transformers, two for installation at Fleet, and one each for Exeter and Taunton.

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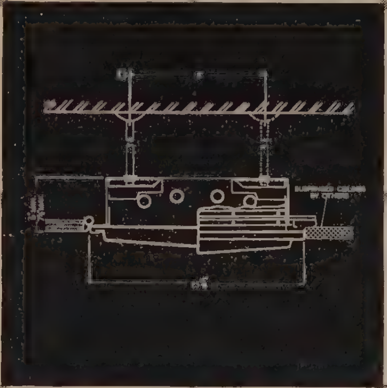

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DTV A275

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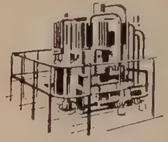

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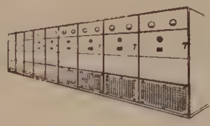

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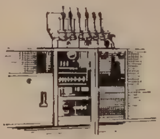

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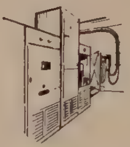

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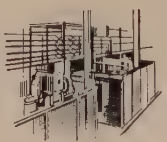

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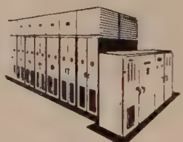

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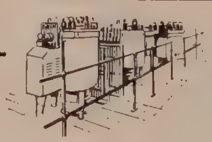

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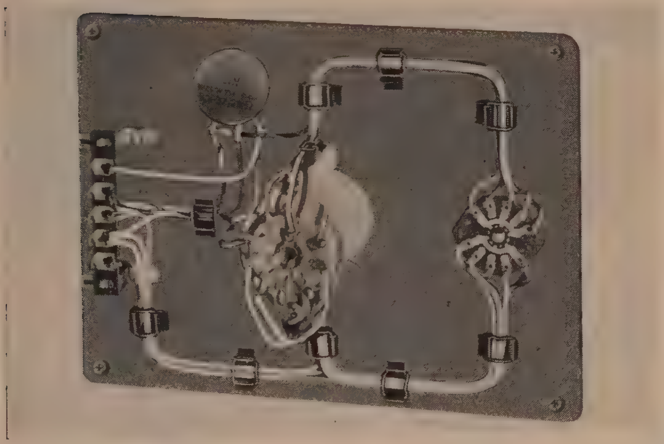

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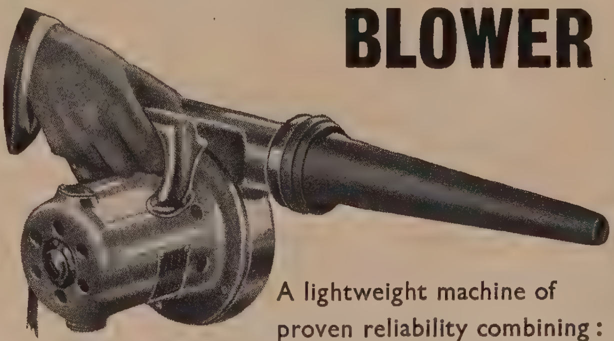

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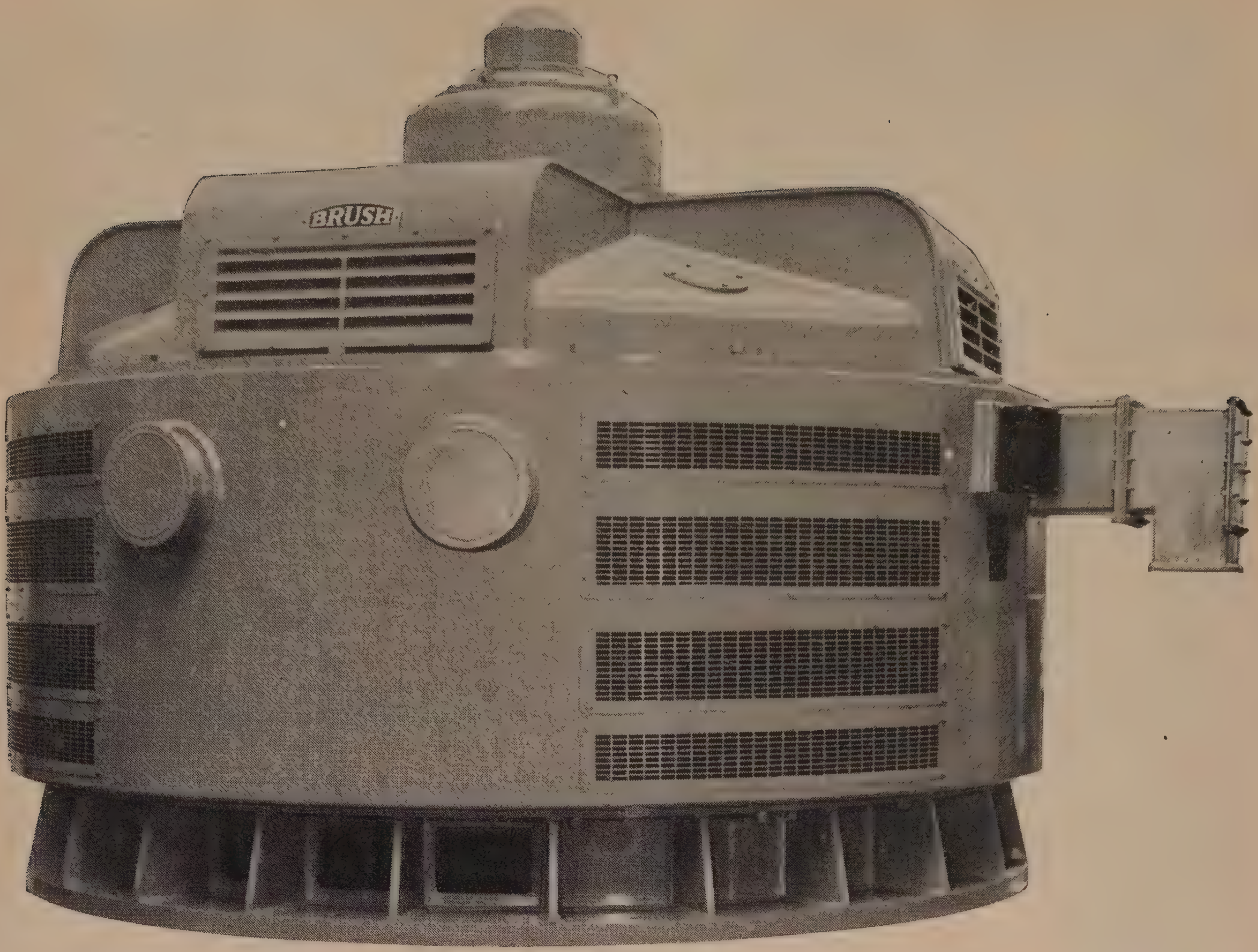

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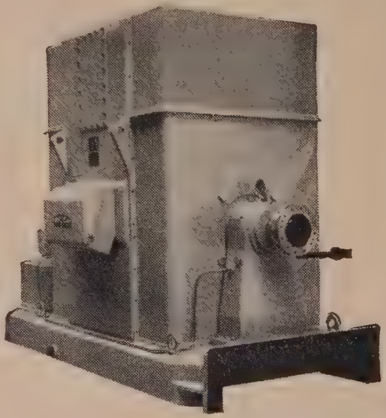

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FRIDAY
22 JANUARY
1960

ELECTRICAL REVIEW

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ELECTRICAL REVIEW

22 January 1960 Vol. 166 No. 4 Established 1872

Giving Them the Tools

WITHIN the last year or so there has been a marked liberalisation of international trade. We have commented on this before, particularly in those cases where the British electrical industry will be likely to encounter increased competition as a direct result of this liberalisation. It is reassuring to know, however, that the British electrical industry is in a very good position to hold its own in the international market, as some notable recent instances have demonstrated. Some of our other industries are in a less happy position and, moreover, show little sign of responding to increased competition in the only effective way—by re-equipping plant and re-appraising attitudes of management and relations within industry.

We feel that at the present time too many British goods are being manufactured by obsolescent machinery and by outmoded techniques. The managements responsible for this state of affairs comfort themselves with woolly thoughts about tradition and comfortable bromides about craftsmanship. It is obvious that no such thoughts were in the minds of men like Watt and Boulton when they introduced steam power into industry, or Brunel when he was devising his gigantic projects, nor of the men who founded the electrical industry.

Today it is unfortunately only too common that when enterprising companies install the most up-to-date plant and machinery it is frequently of Continental or transatlantic origin. A speaker in a recent broadcast referred to those British firms producing equipment for automation and said that many of them could not sell their wares in some sectors of the British capital equipment manufacturing industry. Unfortunately in one sense and fortunately in another they found that the bulk of the demand for their products came from overseas manufacturers.

In the Physical Society's exhibition of scientific apparatus and instruments, which is reviewed elsewhere in this issue, there are to be seen, alongside the communications, measuring and purely scientific instruments, techniques capable of being made the basis of methods of machine tool control of the most advanced kind. Some of these include the techniques of precise positioning or measuring of displacement by means of moiré fringe light diffraction patterns, the production of highly rectilinear motion by "beam riding," and numerous electromagnetic methods of sensing and controlling both linear and rotational displacements.

If the desired rise in the general standard of living is to be attained it can be done only by a continued improvement in manufacturing efficiency. Consequently these and similar techniques must find their way into much more of the equipment which will be shown—and bought—at trade exhibitions in this and subsequent years.

INSTITUTION MEETINGS

The programme for the forthcoming London meetings of the Institution of Electrical Engineers has just become available and it would appear that there is a continuation of the trend in subject matter which has been evident for the past few years. We refer, of course, to the preponderance of papers dealing with radio, electronics and allied subjects. In the programme for the second half of the current session there are twenty-one meetings at which papers will be presented and we feel certain that two-thirds of these will contain little of interest to electrical power engineers.

A similar state of affairs exists in connection with both the lectures and discussion meetings. This may well be due to the fact that the bulk of the developments in the electrical industry are taking place in the light current and electronic fields, but we cannot help wondering whether the balance of subject matter is quite as it should be, bearing in mind the wide diversity of interest of Institution members.

APPLIANCE APPROVAL SCHEME

In our 4th December issue we reported the formation of a Provisional Board of Management charged with the duty of setting up a national scheme for the approval of domestic electrical appliances. The chairman is Mr. T. E. Daniel, who is chairman of the British Electrical Development Association and of the North Western Electricity Board, and the B.E.A.M.A., the British Standards Institution and electrical wholesalers, contractors and retailers are participating in the scheme.

A sign that the Board is becoming active is given by an advertisement appearing in this issue inviting applications for the post of director of the Provisional Approvals Board which is being established. This is described as " an important post requiring first-class administrative ability and sound judgment " and applicants are also desired to have technical and commercial engineering experience. We think that a great deal of tact, combined with firmness, is also called for in this job.

ROAD LAYING

For many years, the only link between road and electrical engineering has been street lighting, a subject unconnected with the actual road building. The past year has, however, seen an intrusion by electrical engineering techniques into both the design and laying of public roads. For example, a radioactive technique has been devised to measure the variation of the density with depth in concrete road slabs. A lightweight, fully-transistorised battery-operated apparatus has now been developed for measuring the density of compacted soil.

The installation of electrical heating grids in road surfaces to combat the effects of snow and ice is being carried out following experiments by the Road Research Board; two practical applications are at The Mound, Edinburgh, and in the Kingston By-pass reconstruction at Hook. Electrical heating methods reduce the labour required for clearing the road surface of snow and ice and avoid the serious corrosive damage which is caused to motor vehicles by the use of salt. More important still, the accident rate in wintry conditions is bound to be lowered and it is hoped that this fact alone will convince many local authorities of the desirability of adopting the system.

TAKE-OVER BIDS

Competition has arisen between Metal Industries, Ltd., and Electric & Musical Industries, Ltd., for the acquisition of Lancashire Dynamo Holdings, Ltd., which controls a number of companies engaged in a variety of electrical activities. Towards the end of last year the M.I. group made an offer of shares and cash for the L.D.H. capital, equivalent at the time to about 64s 6d for each £1 L.D.H. ordinary share. Last week E.M.I. improved upon this by offering the equivalent, in its shares, of about 80s for each L.D.H. ordinary share.

Lancashire Dynamo Holdings has stated that discussions have been going on for about a year between its board and E.M.I. and in view of this and of the higher bid, the board favours acceptance of the E.M.I. offer. There are also certain advantages in the linking of the electronic sides of the two groups. Later Metal Industries said that it had approached Lancashire Dynamo Holdings eighteen months ago and at the time of our going to press was considering a further offer.

PRICE MAINTENANCE

There is a strong feeling about that the clause in the Restrictive Trade Practices Act which permits an individual manufacturer to fix and enforce selling prices for his products should be repealed. Competition among manufacturers is stimulating; but retail price-cutting can be disastrous. No customer would be prepared to pay the list price if he could get the retailer to knock it down. He would always threaten to take his custom to another shop where he knew he could do better. Margins would be cut and, on their way to bankruptcy, retailers would clamour for reductions in works prices and the manufacturers would be drawn into the maelstrom.

Orderly trading is ultimately to the good of seller and buyer alike and so a reasonable price policy should be welcomed by both parties. One practice which we have advocated in the past would help to ensure this—the quoting of list prices in all advertisements and sales " literature."

EXPORT ISSUE

Next week's *Electrical Review* will be our Special Export Issue. It will contain a survey of world electrical trade with a map and diagrams in colour, an illustrated survey of recent overseas work carried out by British manufacturers, and special articles on various aspects of export trade

Scientific Instruments and Apparatus

By P. L. DEGEN, B.Sc.(Hons.)

The exhibition of scientific instruments and apparatus, which is organised each year by the Physical Society, is being held in the halls of the Royal Horticultural Society, London. The exhibition, the forty-fourth in the series, was formally opened on 18th January by the president of the Physical Society, Mr. J. A. Ratcliffe, and closes at 3 p.m. this afternoon, 22nd January

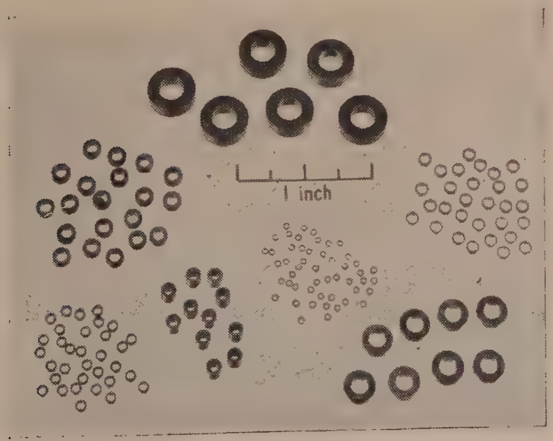
AMONG the instruments and apparatus shown at this year's Physical Society Exhibition perhaps the dominant trends were the increased use of solid-state devices, usually transistors and diodes, often wired into printed circuits, and the increasing use of digitising techniques. Typical of the latter is a range of instruments which includes three- and four-digit voltmeters, both of which indicate polarity by means of the background colour, and cover voltage ranges respectively of 1 mV-99·9 V and 100 μV-1,599 V with accuracy of ±0·1 per cent of full scale and built-in Weston standard cell. There is also an analogue computer digital voltmeter, and an analogue-digital convertor accepting voltages of 1 mV to 15·999 V: the digital output is available in parallel form from 17 gates, which can be interrogated sequentially to give a serial digital output. A digital data recorder comprises a 50-way channel selector, followed by the four-digit voltmeter referred to above, and a printer. Channels can either be automatically sampled at two channels per second, or receive a single scan at external command, or be selected manually at random.

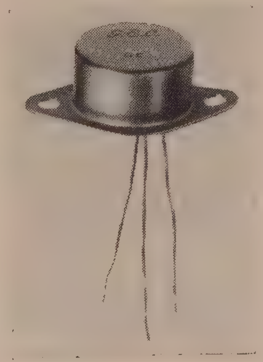
Another range of analogue digital convertors have a minimum detectable increment of 10 μV. A voltage-digital convertor, developed by a Service establishment, was designed for feeding high accuracy, real time information down a standard telemetry link. It is fully transistorised and can take up to 6,000 independent voltage readings per second, each with an accuracy to about 0·01 per cent of full scale. Conversion is by the trial voltage method in which the digits in the register are set up in turn, starting with the most significant, by comparing appropriate fractions of a highly stable reference voltage with the input; the reference voltage of 7·5 V has a short-term stability of two parts in 10^5 while subjected to 10g vibrations from 30 c/s to 2,000 c/s, and consists of a simple series voltage stabiliser using three zener diodes and three transistors mounted in a small temperature-controlled oven. An even higher switching rate of 10,000 conversions per second is achieved in a prototype analogue-digital convertor used in a data reduction system for the "quantising" of transient signals for digital recording. It incorporates a sample and hold device with a sampling aperture of 1 μsec and a hold time of 90 μsec.

A range of digital circuits utilises an experimental alloy-junction transistor with an alpha cut-off frequency exceeding 10 Mc/s and an experimental aluminium-bonded diode. Data processing operations are carried out at a digit rate of 1 Mc/s and at a maximum ambient

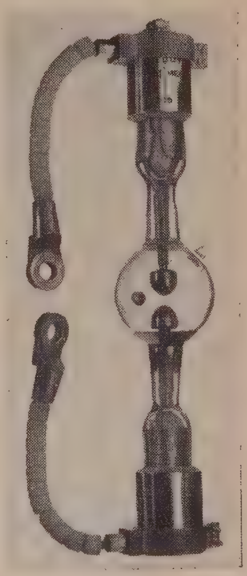
Cast permanent magnets of high BH_{max}: Plessey

Square loop ferrite cores for memory stores: Plessey





Three-junction semiconductor device for use in power control and power switching applications: G.E.C.



1,750 W arc discharge lamp: A.E.I. (Woolwich) temperature of 45°C. Direct coupling is used between units in order to obtain uniform operation irrespective of the time pattern of the pulse signals. Each 1 μsec digit period is terminated by a common discharge pulse of short duration that restores all transistors by removing minority carriers from the base regions. Magnetostrictive delay-line stores have delays of 100 μsec and 1 msec, thus storing 100 and 1,000 binary digits respectively.

Solid-State Devices

A range of solid-state devices included what would appear to be the ultimate in miniaturising of circuits, by means of the selection and shaping of conduction paths upon and through a semiconductor wafer. The equivalent component density can be as much as 50,000,000 per cu ft, and an example shown was a multi-vibrator circuit measuring $\frac{1}{4}$in by $\frac{1}{8}$in by $\frac{1}{32}$in. The manufacturing processes are similar to those employed in the manufacture of diffused-base transistors, including diffusion, metallic evaporation and etching. The last two processes are controlled by photographic masks, permitting the economical production of small quantities of circuits. Resistors are formed by the bulk resistance of the material, capacitors by utilising the capacitance of a large area p-n junction, and transistors and diodes by diffusion methods. Diffused-base silicon and germanium transistors have alpha cut-off frequencies up to 600 Mc/s; a switching transistor has a rise time of 60 mμsec and fall time of 80 mμsec, an alpha cut-off frequency of 300 Mc/s, a total power dissipation of 300 mW at 25°C and an operating junction temperature range of -55°C to $+100$°C, while power transistors have maximum collector currents up to 25 A, voltage ratings up to 80 V and dissipation of 80 W at 25°C. A silicon rectifier has a maximum peak inverse voltage of 1,500 V and a case size of 0·6in by 0·21in diameter while another is rated at 150 A. Other ranges of p-n-p-n silicon-controlled rectifiers are available providing 3 A maximum forward current with 400 V inverse voltage, and up to 10 A with 200 V inverse voltage.

R.f. power amplifier beam tetrode: G.E.C.

900 Mc/s magnetron, using ceramic-metal seals: A.E.I. (Rugby)

Another application of semiconducting materials is in photocells, where not only silicon and germanium, but the newer compound semiconductors are employed, as in a photovoltaic infra-red detector based on a diffused-junction indium antimonide wafer operated at the temperature of liquid nitrogen. Another application of this material is in the detection of very weak magnetic fields by means of the Hall effect. One instrument measures magnetic susceptibilities of the order of 10^{-8} c.g.s. units by detecting the change in reluctance of a magnetic circuit when the specimen is inserted in an air gap. The same semiconductor can be used to detect movements of the order of 1 Å (10^{-8} cm) by means of the change in electrical resistance produced by movement in a region of magnetic field gradient. Yet another new semiconductor material is gallium arsenide. Regulator diodes utilising this material have an operating temperature range from -65°C to $+325$°C.

Other new materials include thin films of magnetic alloy evaporated in a uniform magnetic field. Such films when placed in magnetic fields have two stable states of the magnetic vector, thus permitting information to be stored in binary form. Transitions between steady states are accomplished in tens of millimicroseconds.

New grades of ferrite material for square loop construction require a lower switching current than previously, and by using special techniques with the two core per bit system, high-speed stores with a cycling time of only 1 μsec can now be produced. On the same stand there was also displayed a new range of cast permanent magnets in an alloy which has the high value of BH_{max} of $5{\cdot}2 \times 10^6$ gauss-oersteds, even in large castings.

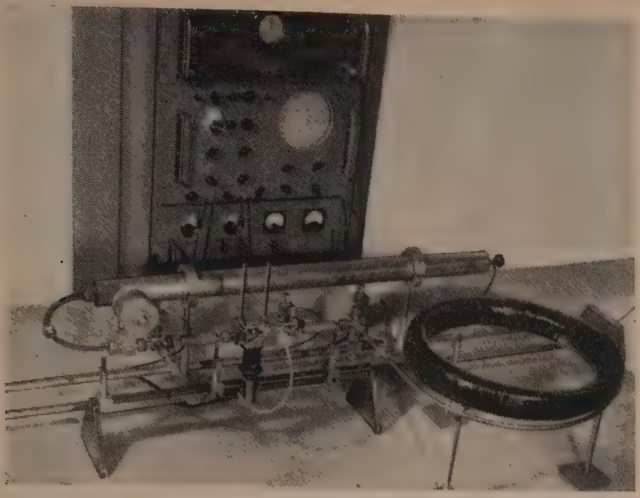
A submicrosecond magnetic matrix store system uses two cores for each digit stored. During the writing operation both cores are driven from one remanent state towards the other with a 0·1 μsec current pulse which only partly switches the cores. At the same time, a digit pulse of much smaller amplitude is applied to the two cores in such a direction that it aids the " write " pulse in one core and opposes it in the other. Upon the application of the " read " pulse in the opposite sense, the core which has switched further provides the larger output on a wire threading the cores in series opposition, indicating polarity.

New forms of capacitor construction included sheets of barium titanate, 0·005in thick, interspersed with thin nickel electrodes produced by simultaneously sintering barium titanate and nickel in a reducing atmosphere, and sandwiches of thin metal films with magnesium fluoride as dielectric, enabling a capacitance of 2,000 pF at 25 V d.c. to be obtained within an area 5 mm square. Resistors consisting of nickel-chromium films about 75 Å thick are processed to give values up to 100,000 Ω in a similar area. A novel material for the construction of resistors is a glass fibre of about 1 mil diameter coated with an oxide film and having a resistance of up to several megohms per inch, thus enabling extremely compact high-value resistors to be made by winding the fibre on to glass or ceramic formers.

Electroluminescent devices with both organic and inorganic dielectric are shown. In the former class are digital display units and co-ordinate display units in which the electrodes are divided into two perpendicular sets of parallel lines, while in the latter class are a wide range of shapes and sizes of panels, utilising ceramic electroluminescent layers, including one type which emits yellow light when excited by a d.c. potential, but blue or green light when excited by a.c.

Light Sources, High and Low Frequencies

A compact high-pressure mercury vapour arc discharge lamp of 1·75 kW rating can be switched on and off without delay, unlike earlier forms of this lamp. Applications envisaged include use in optical systems, in which the small size of the light source enables relatively small reflectors to be used, and fadeometers, photogravure work, etc., where the large output of long wavelength ultra-violet radiation can be utilised. A very short pulse of light (10-20 mμsec with a build-up time of 1 mμsec) is obtained by modifying a standard millimicrosecond pulse generator so as to permit visual access to the coaxial



Measurement of very low attenuation in waveguides: A.E.I. Research Laboratory

mercury relay employed in it. This is of value in investigating the behaviour of photomultiplier tubes under similar conditions to those obtaining in a typical scintillation counter.

Photographic Intensifier

An image intensifier tube is intended to increase effectively the speed of photographic film when photographing very faint images: it has a single stage and unity magnification and multistage tubes are being developed. Amongst new valves is an r.f. beam tetrode giving 100 W up to 30 Mc/s and a 50 kW triode for industrial r.f. heating with the comparatively low operating voltage of 6 kV. The use of microwaves for heating has the advantages of faster heating and lower electric stress than with conventional low r.f. heating techniques. The heating may be rapid and uniform throughout the material without the usual heat conduction limitations. The material to be heated, in the shape of blocks, sheet or strips, is passed through a resonant cavity which is arranged to provide a matched load for a magnetron by adjustment of a coupling iris and a tuning plunger, the reflected power being monitored by a directive coupler and detector. The magnetron itself generates a 900 Mc/s continuous wave at $2\frac{1}{2}$ kW, and makes use of ceramic-metal seals of high mechanical strength and good electrical properties.

Other exhibits include klystrons and travelling-wave tubes. An electron-beam parametric amplifier in which the fast space charge wave is amplified, rather than the slow space charge wave as in the other tubes mentioned, is also demonstrated. It is possible to remove the cathode noise from the fast space charge wave before the signal is applied and the possibility therefore exists of amplifying weak signals while keeping down the noise level.

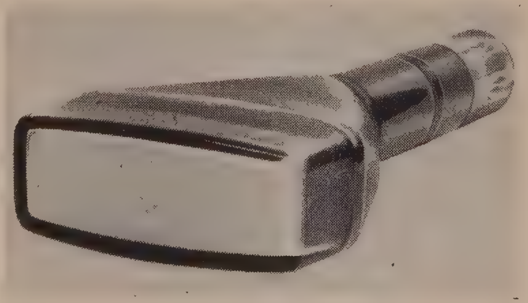
A signal generator designed to cover the wide range of 4-12 Gc/s consists of a klystron oscillator mounted in a coaxial line cavity, the output of which is available either directly or through a precision piston attenuator. A power monitor is incorporated that indicates a 1 mW level from the piston attenuator when the setting is 0 dB attenuation, frequency is read on a vernier dial, and attenuation is shown in dB on a dial gauge. A self-calibrating wavemeter for the range 1-9 Gc/s is shown on the same stand.

The frequency of oscillation of a reflex klystron may be controlled over a limited range by varying its reflector voltage and, conversely, if any ripple appears on the reflector voltage supply the klystron will be frequency modulated. In some applications, this cannot be tolerated and power supplies of extreme stability are required. Such a power pack is now available, the total noise plus ripple not exceeding 1 mV in an output of 2·4 kV, i.e. about 4×10^{-7} of the output. Another power pack for less demanding klystron applications provides 400 V for accelerating, 750 V for retarding fields and smoothed variable d.c. supplies for heaters. An internal oscillator covering the frequency range 400 c/s-4 kc/s provides a square-wave signal for amplitude modulation at the cathode or the reflector and a triangular wave signal for frequency modulation at the reflector.

V.L.F. Generator

At the other extreme of frequency, come apparatus such as the v.l.f. function generator with an output of any required function or wave shape over the frequency range of 0·01 c/s-100 c/s. An optical-mechanical system is employed whereby a narrow slit of light is scanned by a rotating disc on which is impressed an opaque area corresponding to the function to be produced. The rotating disc can readily be interchanged when the wave shape is to be varied, and it is driven via a four-speed gearbox by a servo-controlled motor to achieve frequency accuracy and stability. There is also the facility for automatically sweeping the two higher frequency ranges when required in vibration testing or similar applications.

Electronic means are employed to provide frequencies between 0·01 c/s and 1 kc/s in another instrument. The oscillator employs a selective circuit comprising a phase invertor and two integrators. Positive feedback from a diode limiter circuit effectively controls the oscillation amplitude at all frequencies. The distortion introduced by the limiter at the input stage is reduced to negligible proportions in the output. At the frequency of oscillation each integrator provides a phase shift of 90°; thus, a quadrature output is available after the first integrator stage. Another instrument produces sine and square waves within the frequency range 0·03 c/s-30 c/s, and a ramp waveform with a settling period.



High aspect ratio radar cathode-ray tube: G.E.C.

A crystal-controlled variable-frequency square wave generator is transistorised and is basically a batching counter arranged so that a d.c. level change is produced after a certain count has been reached, at the end of which the count section resets and on reaching the required total changes back the d.c. level at the output to its previous value. If the instrument is fed from an oscillator whose frequency is accurately known and if the frequency is chosen to be a convenient multiple of 10, then the half-period of the resultant square wave can be set directly in milliseconds or multiples thereof and, by altering the settings, the frequency of the output can be varied whilst maintaining a mark space ratio of 1:1 to a very high order of accuracy, which is increased as the frequency of the square wave is lowered.

Cathode-Ray Oscilloscopes

Among the oscilloscopes on display are two designed for the study of non-recurrent phenomena by means of long-storage cathode-ray tubes. In the case of one instrument, a writing speed of 2 cm/μsec is available, and storage times of the order of a week, during which time the trace may be displayed for a total period of two hours which may be taken either in its entirety or piecemeal. The vertical amplifier is direct coupled and has a bandwidth of 4 Mc/s, and the time base sweep velocity is variable between 0·3 μsec and 10 sec/cm. The other instrument of the same type has two vertical deflection channels, each having a direct-coupled amplifier with 1 Mc/s bandwidth and both being simultaneously displayed by means of high-speed switching. The horizontal deflection channel has also a bandwidth of 1 Mc/s, and the time base has 43 calibrated sweep times, ranging from 1 μsec/cm to 10 sec/cm, while trigger delay variable from 10 sec to 100 sec is provided.

A double-beam oscilloscope has two identical amplifiers with a pulse-corrected response from d.c. to 3 Mc/s and compensated attenuators giving sensitivity ranges from 50 V/cm to 0·5 V/cm; the time base is adjustable for either triggered or repetitive operation and covers from 0·2 μsec/cm to 5 sec/cm on calibrated ranges. A single-beam instrument has a bandwidth from d.c. to 15 Mc/s, sensitivity from 50 mV/cm to 25 V/cm; and time base from 50 mμsec/cm to 15 msec/cm, while another high-speed oscilloscope has a bandwidth from d.c. to 40 Mc/s with a rise time of 9 msec. The sensitivity is 100 mV/cm, or variable between 10 mV/cm and 12 V/cm over a bandwidth from 2·5 c/s to 20 Mc/s; and the time base is variable between 10 mμsec/cm and 0·5 sec/cm.

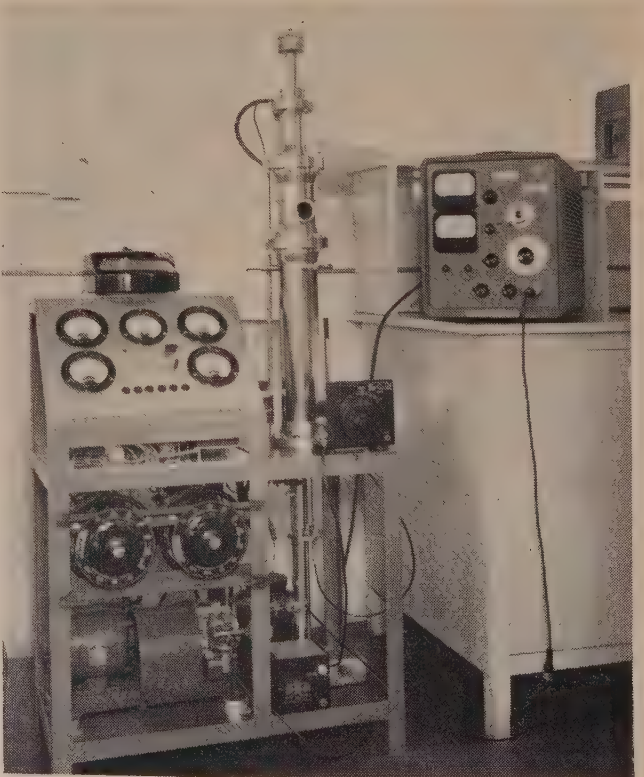
An oscilloscope intended for lecture and demonstration purposes employs a 12in cathode-ray tube and all controls are grouped at the rear, while windows in the sides of the cabinet permit viewing of the trace on the rear of the tube. Both X and Y amplifiers have the same response and there is a two-beam switch to enable two waveforms to be shown simultaneously. A prototype transistor for oscilloscope is completely self-contained, operating from an internal accumulator, and weighs only 10 lb complete. It is therefore useful for field work, and can be used as a general purpose oscilloscope up to about 50 kc/s. Y-amplifier sensitivity is variable from 30 mV/cm-30 V/cm and the use of a transistor buffer stage enables a constant input impedance of 1 megohm to be maintained for all sensitivities.

Cathode-ray tubes on display include a type suitable for operation from comparatively low-voltage supplies for applications such as that described above, and in monitors in remote positions where cathode-ray tubes are not normally found, and therefore only equipment voltage supplies are available. The use of novel chemical techniques in the laying of the screen has permitted tubes to be manufactured with a minimum h.t. rating of 350 V. Other special cathode-ray tubes included a high-resolution tube for xerographic printing, a tube with a special transparent phosphor and an electroluminescent digital display panel. Rectanguar cathode-ray tubes of high aspect ratio permit high densities of stacking and minimum wastage of panel space.

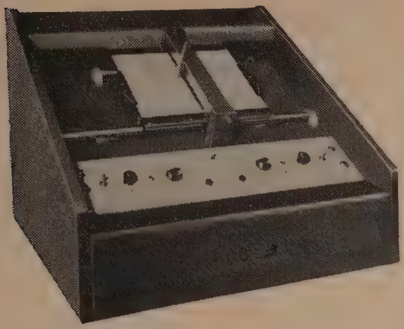
A refined oscilloscope camera has a timed shutter speeded from 1 to 1/125 sec and an f/3·5 lens with iris diaphragm in focusing mount. A Polaroid-Land fast processing unit built into the camera body permits a black-and-white positive print or transparency to be examined one minute after exposure. Another special camera also incorporating a Polaroid-Land unit is designed for use on the Vickers projection microscope. A close approach to this speed of processing is provided by an automatic film processor which handles 35 mm film. It can be employed as the link between a continuous feed camera recording, for example, traces on a cathode-ray tube screen and a projector throwing a continuous image on a screen. The film is developed, fixed, washed and dried at a speed of one inch per second.

Other ranges of cameras include one with a capacity of 200ft of 70 mm film and an electrically-triggered focal plane shutter, which is also capable of continuous moving film recording, and others for 35 mm film in various loadings with electrical operation. A 16 mm camera makes repeated exposures of up to 55 sec, with an interval between consecutive exposures variable between 2½ sec-1 hour. Power supplies of 12 or 24 V d.c. or 200/250 V a.c. can be accepted.

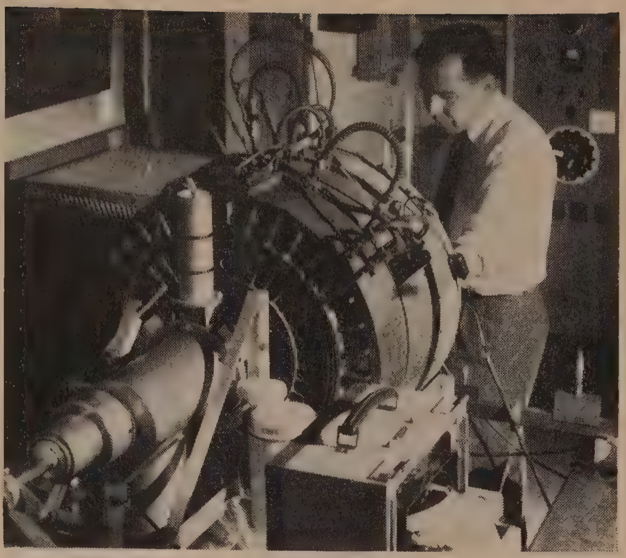
A miniature light-operated switch can be used where-ever a change in light intensity is required to perform a switching operation, and consists of an interleaved comb photo-conductive cell, a two-stage transistor d.c. amplifier and a relay. Operated from a 12 V d.c. supply a maximum current of 80 mA is required, and the relay will make or break the current of up to 10 A. The complete unit is contained in a 2in cube and operates on a light intensity of 20 microlumens/sq cm. Another form of photocell is designed to be highly position sensitive and a test rig was demonstrated in which displacements of the order of a microinch were detected, either by means of a photo-e.m.f. which changes its polarity, passing through zero in the central position; or by means of an a.c. output which changes its phase at the null point. Two applications in machine tool control are fringe counting and beam riding. In the former case the device offers the unique advantage of providing a truly balanced a.c. out-



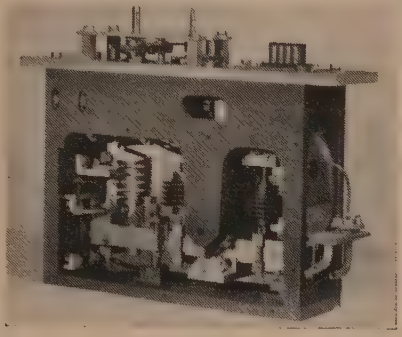
High-temperature dielectric measuring apparatus: Plessey



X-Y recorder: Ekco Electronics



Electron-beam parametric amplifier: G.E.C.



Force balance unit: Kelvin Hughes

put which can be amplified to give a fractional fringe sensitivity limited only by the electron and photon noise of the detector. The rectilinear motion of the machine tool may be controlled by forcing the detector which is fixed to the tool to traverse a thin pencil of light under servo control. It is thus possible to produce highly rectilinear motions without the need for precisely machined ways.

Moiré Fringe Technique

Many other stands have exhibits based upon the use of moiré fringes for the measurement and control of the movement of machine tools, etc. The fringe systems are formed by two diffraction gratings, and as these are moved relative to each other, the fringe system indicates both the direction of the movement and its magnitude, with very considerable magnification. In one application shown, optical spectra of trans-uranic elements, which contain literally thousands of lines, are automatically scanned, while the movement of the carriage is measured by a fringe counter such that one μmicron movement produces one count on a dekatron. In another application, the rotating fringe system is detected by a pair of diametrically opposed phototransistors, and for each 360° of rotation, 1,000 pulses of uniform size result in either of two channels, depending on the direction of rotation.

Another method of measuring distances within the range 50 microinch-½ inch is based upon the capacitance between a probe and the test structure. The length of the probe cable is 10ft, thus enabling the instrument to be well clear, and suggested applications include precision grinding processes, the dynamic balancing of helicopter blades and the measurement of verticality of control rods in nuclear power stations. A similar system has been applied to the accurate measurement of the displacements of a microscope stage, thus enabling the finest details to be measured. The attachment is suitable for any type of microscope.

A wide range rotation speed indicator permits the instantaneous measurement of rotation speeds down to 0·1 r.p.m. with high accuracy. The essential principle is the determination of the speed of rotation of a conducting structure by observation of the magnetic field resulting from circulation currents induced by a primary magnetic field. In the preferred form, this induced field is observed by means of a second harmonic type flux detector, and the great sensitivity of this form of flux detector is utilised to observe a null field created by the opposition of the induced field and an opposing field produced by a feedback winding.

A small electronic tachometer for the measurement of the rotation speed of internal combustion engines is housed in a metal case 3½in in diameter by 2½in suitable for dashboard fitting. It contains a transistorised monostable oscillator triggered by the h.f. pulses from the ignition coil, which are picked up by a lead coiled round the h.f. lead. The variation of pulse repetition rate causes the mark/space ratio to change, and the resultant change in d.c. level indicates the speed of rotation in r.p.m. on a 270° arc meter.

A rotating machinery noise analyser was originally developed to carry out routine testing of automobile gearboxes for noise arising from gear meshing at the various gear speeds, over a wide range of input shaft speeds. A series of toothed wheels is mounted on the drive shaft, having numbers of teeth on each wheel chosen to suit the various gear meshes, and the frequency of the signal derived from a magnetic pick-up sets the tuning frequency of the analyser. The pass band is rectangular in shape and there is a rejection of over 50 dB of signals outside the pass band. The analyser operates over a frequency range of from 2 c/s to 20 kc/s, and can also be operated as a conventional wave analyser.

A variety of transducers included a lead zirconate accelerometer which can be operated over a temperature range of −50 to +250°C with short excursions beyond, and potentiometer accelerometers for the measurement of static and dynamic accelerations up to ±100g in which the seismic mass is totally immersed in silicone fluid. An absolute pressure transducer consists of a thin-walled metal cylinder which forms a mechanical resonant system of high Q. When pressure is applied externally to the cylinder, the effective stiffness of the system is reduced, thereby causing a decrease in the resonant frequency. The vibration is maintained electromagnetically by means of a driving coil and a pick-up coil within the cylinder, the system of coils and cylinder forming the feedback path for a transistor amplifier. Pressure ranges between 0 to 25 and 0 to 600 p.s.i. can be measured with an accuracy of 1 part in 1,000.

A method of pressure measurement which avoids the inherent defects of a deflection instrument utilises a beam supported by frictionless cross-spring pivots and carrying at one end an inductive pick-off. Two pressure capsules and a high-precision spring complete the force balance: a pressure change within the capsules causes the beam to deflect and the signal from the pick-off is amplified and fed back to the control phase of a servo-motor, which adjusts the tension of the spring by means of suitable gearing and a leadscrew until balance conditions again occur. The rotation of the shaft is a function of the pressure change within the capsules and can be made to drive a pointer. Two versions were exhibited, each having a range of from 0 to 31in Hg differential and 0 to 33in Hg absolute, and with accuracies of ±0·05 per cent and ±0·2 per cent respectively.

An automatic reading planimeter gives a digital presentation of a measured area on four cascaded cold-cathode counter tubes and automatically transfers the results to a read-out printer which allows any number of individual areas to be added or subtracted. The electrical system is based upon a transparent disc on which are engraved 200 radial lines with a mark/space ratio of 1 : 1, and is the electronic equivalent of a standard four-digit reversible mechanical counter but capable of operating at a maximum speed of 4,000 counts/sec.

A high-speed X-Y recorder plots the relationship between two interdependent variables directly on standard 10in by 7½in graph paper. The wide sensitivity range and fast response of 200 millisec for full-scale travel enable rapidly-changing parameters to be charted accurately. The input impedance is 1 MΩ and the sensitivity range on each axis is variable between 1 mV/in and 10 V/in.

Measuring Instruments

A radio frequency bridge which has been developed since being shown the previous year covers the frequency range from 15 kc/s to 15 Mc/s, and will measure capacitance from 0·01 pF to 25,000 pF, inductance from 0·5 μH to 500 mH and resistance from 10 Ω to 10 MΩ with an accuracy of 1 per cent up to 10 Mc/s increasing to 2 per cent at 15 Mc/s, but can be operated with decreasing accuracy up to 25 Mc/s. The transformer ratio arms are arranged around a neutral point thus enabling the bridge to measure any pair of terminals in a three-terminal network, and it will also measure most of the useful transistor parameters, with the addition of a plug-in adaptor and a control box to apply the necessary d.c. bias. Other bridges provide illuminated numeral read-out and transistor circuits.

A precision decade potentiometer has decade switching throughout and no slide wires whatever. The first decade is combined with the range-change switch so that the instrument is direct reading on all ranges, and an accurate five-decade current control is included giving variations in current in steps down to one part in 10^6. Three ranges cover from 0·1 μV to 1·99999 V and the accuracy of potential division is to ±0·001 per cent. Another potentiometer comprises a primary section having two dials giving 20 steps of 0·1 V and 100 steps of 0·001 V respectively, and a secondary giving 100 steps of 10 μV and 0·1 μV respectively. The primary potentiometer is standardised directly against a standard cell in the usual manner and the secondary is standardised against a section of the primary. The four potential-measuring dials are mounted in line; each dial is provided with stops at zero and at maximum value and these can, with slightly more than usual pressure, be overridden so that the switch can be turned directly between zero and maximum. This simplifies the setting of the dials when the final value is uncertain.

Measurements of permittivity and power factor of dielectric materials can be made over the frequency range 100 Mc/s-1,000 Mc/s at high temperature in two equipments shown. In both cases the specimen, in the form of a 1in diameter disc, is mounted between the plates of a micrometer-controlled variable capacitor forming the termination of a quarter-wave, 50 Ω coaxial cavity. In one form, hot air is passed through the apparatus, and the temperature of the dielectric (up to 150°C) is measured by a thermocouple in one of the capacitor plates. In the other form of this equipment, the capacitor electrodes act as miniature hot plates. Specimen temperatures of over 500°C may be achieved, and the bearings of the capacitor are air cooled, while the coaxial line cavity is evacuated.

An automatic waveguide impedance indicator provides a continuous cathode-ray tube display of the complex reflection coefficient of a waveguide component. Indication of the reflection coefficient is derived from simultaneous measurement at three fixed points of the relative amplitude of one of the field components of the waveguide by means of a special bolometer unit developed for the purpose. Low attenuation corresponding to Q values of 10^6 can be measured in waveguides by means of a frequency-modulated klystron which sweeps through the resonant frequency of the cavity. The small frequency differences are measured by a waveguide delay-line frequency discriminator, the output of which is capable of accurate absolute calibration. An oscilloscope displays the resonance curve on a calibrated frequency scale obtained from the discriminator, so that the width of the curve can be read off directly in frequency units. The measurement is independent of the rate and linearity of the sweep, and hence makes no demands on the frequency stability of the klystron.

Impedance measurements over the range 115-130 Gc/s are carried out by means of a 2·5 mm reflex klystron used as a signal generator with a maximum power of 30 mW, and coupled to a hybrid tee bridge via a sliding screw tuner, a vane attenuator, a probe coupler and a rotary attenuator. The impedance to be measured is compared with a direct-reading variable impedance, and the bridge balance is checked by a crystal detector.

A stand near the entrance displays the products of a number of Swiss firms, including equipment for the control of radioactive contamination in liquid by scanning the residue left behind on a heated moving band with a scintillation counter, and apparatus for the automatic recording of titration curves. A 1 : 10 scale model of a 4 MV ion accelerator, an electron diffractograph and sections of magnets weighing up to 58,000 lb and having an induction of 16 kilogauss in an air gap of 5½in are also shown.

Evening Discourses

The usual custom has been followed of holding evening discourses on a wide range of subjects during the course of the exhibition. Thus, on Monday evening, Flight Lieut. J. Billingham, of the R.A.F. Institute of Aviation Medicine, spoke of the reactions of the human body to the stresses of high-performance flight and, on the following evening, Dr. L. Essen, of the National Physical Laboratory, described the caesium frequency standards developed at the N.P.L., which enable the working standards of frequency to be calibrated in a few minutes with a precision of ±1 part in 10^{10}, and mentioned the consideration being given to the linking of atomic and astronomical systems of time. On Wednesday evening, Dr. D. A. Wright, of the research laboratories of the General Electric Co., Ltd., discussed recent advances in solid-state physics. In parallel with a general advance in solid-state theory, there have been improvements in the performance of semiconductor diodes and transistors as regards frequency, power and stability, and an extension of the temperature range over which they will operate; the solid-state analogue of the thyratron has been developed; and new types of two-electrode structure have appeared, resulting in low noise level amplification, and in higher frequency operation. The understanding and control of photo-conducting materials has improved considerably, and there has been some progress in phosphors and electro-luminescence. Switching and storage devices operating at liquid helium temperatures are being perfected, while the maser also operates at very low temperatures. The development of new semiconducting compounds has resulted in great improvement in the performance of thermo-electric devices, both for refrigeration and for the generation of electricity.

FLUORESCENT LIGHTING FROM D.C. SUPPLIES

Transistor-Inverter Operation

SUBJECT to certain limitations, power transistors may be used in conjunction with most types of gas-discharge lamp, but in a paper prepared by Messrs. I. F. Davies and D. Dunthorne and presented to the Utilisation Section of the Institution of Electrical Engineers on 14th January, their use in relation to low-pressure hot-cathode fluorescent tubes only is considered. Until recently the operation of these tubes from d.c. supplies was attended by a high ballast power dissipation and loss of light output due to electrophoresis—the migration of positive mercury ions to the cathode. It was impossible to operate these lamps directly from d.c. supplies as low as 24 V and for such applications d.c./a.c. inversion equipment was necessary. Rotary inverters, vibrators and mercury-jet inverters have been used, mainly in public transport vehicles, but all have inherent wear and maintenance problems associated with moving components. During the last two years self-driven inverters, using germanium power transistors, have been designed to operate from d.c. supplies from about 12 up to several hundred volts. These can be associated with a single fluorescent tube and ballast or can be constructed as a power pack to supply a.c. to a number of separate lamp-and-ballast combinations.

As the operating frequency is increased, some of the lamp parameters change, particularly voltage, which changes from a square to a sine waveform. With a sine wave lamp current, this results in an increased lamp waveform power factor and an increased luminous efficiency. Other factors are lower cathode losses and greater production of the ultra-violet radiation which excites the lamp phosphor. There appears to be little advantage in using supply frequencies greater than about 20 kc/s since the efficiency/frequency curve levels off at this point. It is not expected that lamp life will be worse at high frequencies than at 50 c/s. An adverse effect of the use of high-frequency supplies is the increased voltage required to start the lamp. The physical size of the lamp ballast decreases as the supply frequency increases; this is advantageous in transport lighting installations where space is at a premium.

After considering the characteristics of self-driven square-wave and sine-wave transistor inverters, the authors dealt with design considerations and components of practical sine-wave inverters. The transistor characteristics required are high peak and mean current ratings, low internal base resistance, low intrinsic thermal resistance, a high maximum junction temperature (in this respect silicon transistors are preferable to germanium), a cut-off frequency of the order of 350-500 kc/s and high reverse-voltage characteristics.

A practical inverter must accept a range of input voltages, e.g. a nominal 24 V lead-acid battery as encountered in aircraft lighting will have a voltage range of 22-30 V, and to ensure satisfactory operation the base resistance must be adjusted at the lowest voltage, but some over-drive will occur as the voltage is increased. When an inverter is being operated with an inductive ballast at a frequency at or above the transistor cut-off frequency, the frequency will fall in the lamp-starting condition rather than rise as it does with a capacitive ballast, which is undesirable. Also the lamp current waveform is sinusoidal, while a capacitive ballast will magnify any harmonics in the inverter output voltage. A capacitive ballast, however, will generally be lighter and cheaper than the equivalent inductive ballast. Although also cheap and light, a resistive ballast is generally not considered because of the large power loss involved.

Frequency and Q-factor

An important factor in the design of an inverter transformer is the leakage inductance between the primary winding, the feedback windings and the secondary winding across which the tuning capacitor is connected. If appreciable leakage inductance exists, it is possible for the inverter to oscillate simultaneously at two different frequencies. To obtain the two requirements of frequency of operation and Q-factor of the secondary tuned circuit, it is generally necessary to have an air gap in the transformer core which normally precludes the use of toroidally-wound transformers. Allowance must be made when choosing capacitors for the limitation imposed by supply frequency on the working voltage and power loss.

The choice of operating frequency will depend on such considerations as lamp luminous efficiency, size of components and cost, characteristics of available transistors and noise. The higher the frequency the smaller will be the wound components. For frequencies up to about 1 kc/s, silicon-iron cores may be used in chokes and transformers, and these are relatively cheap. Above 1 kc/s, more expensive nickel-iron cores are needed to reduce the iron loss and, at about 2 kc/s, ferrite cores become practical.

With the present power transistors the maximum operating frequency is 6-8 kc/s with the transistors working at their maximum peak collector-current rating. For a lower power inverter a transistor with a higher peak collector-current rating than is required may be used, thus obtaining a gain at the peak currents and at frequencies in excess of the cut-off frequency. Using this principle, inverters have been designed to operate at up to 25 kc/s. Wound components in an a.c. circuit will cause some noise which may be objectionable. Some special form of noise suppression is needed with nickel-iron cores, owing to the marked magnetostrictive effect of this class of material. Potting materials such as castor-oil-urethane are suitable. The dissipation of heat generated in the transistors is greatest at the base-collector diode, and for this reason the collector in power transistors is mounted directly on to a large mass of metal. Heat from the collector junction passes by conduction into this and thence into some form of heat dissipator. The maximum junction temperature specified by the manufacturer at which the transistor may be operated safely must not be exceeded.

The authors then consider some practical lamp-inverter circuits, including both single-ended and push-pull inverters for sine-wave circuits, the advantages of the latter being twice the power output for a given direct supply voltage, improved lamp-current waveform, owing to the greater symmetry of the circuit, and load disconnection without excessive voltage swings.

Inverters using transistors in series have been made to operate from d.c. voltages up to 140 V, and another method of operating inverters on direct voltages greater than 30 V is to use the "split-battery" type. When inverters operate from such high voltages the output powers become large and it is more economical to use the inverter as an a.c. power pack supplying several self-contained lamp circuits. Since these will normally be individually switched, the split-battery circuit is preferable, since its push-pull nature makes it more reliable in no-load conditions. When a square-wave inverter is used with a lamp having a reactive ballast, the transistors must be protected from damaging voltage stresses, but for resistive loads circuits such as the push-pull, split-battery or bridge type may be employed. In transport applications where several short fluorescent lamps are to be operated from a 700 V d.c. supply, filament heating current for the lamps is supplied from a square-wave inverter operating from an auxiliary battery supply. The same inverter also provides a high-voltage a.c. supply to ensure reliable lamp starting.

Transistor-inverter operated fluorescent lighting installations in the United Kingdom have so far been confined to transport applications. In some coaches on the Caledonian Express 60 inverter fittings were installed, each operating a 20 W fluorescent tube at 1 kc/s. The normal 24 V d.c. coach supply is used. These inverters have now operated for 18 months, and both transistor and lamp performances have been entirely satisfactory. Large numbers of sine-wave inverters are being installed in the Vickers *Vanguard* airliner to operate a 4ft or 3ft fluorescent tube at 15 kc/s from a 24 V supply. Other types range from a 12 V d.c. unit for operating a 6 W lamp in a car to a 110 V d.c. power pack having a total lamp load of about 160 W for use by British Railways.

Export Conference Programme

DETAILS have been announced of the programme of the B.E.A.M.A. Export Sales Conference which is to be held at the Connaught Rooms, London, on Wednesday, 10th February. The theme of the Conference is "Re-arm for Export."

After a welcome by the chairman of the Conference, Mr. Stanley Broughton, managing director, Electrolux, Ltd., Lord Chandos, chairman, A.E.I., Ltd., and Mr. S. Roberts, managing director, Hoover, Ltd., will speak on "The Importance of the Will to Export." The remaining sessions in the morning will be occupied by addresses by Sir Leslie Gamage, president of the B.E.A.M.A. and chairman and managing director of the General Electric Co., Ltd., and by the President of the Board of Trade.

In the first session after lunch Mr. Sven Jansson, managing director of Elektronikbolaget A.B., Stockholm, will speak on "Design for Overseas Requirements." He will tell the Conference what he thinks about the design, styling and technical qualities of British domestic appliances—their shortcomings and, where appropriate, their good points as well—and how to improve selling methods and promotional activities on the Continent. Mr. Colin Baxter, managing director of the United Africa Co., Ltd., will then speak on "Export Marketing Methods." Finally there will be a question and answer session, under the chairmanship of Mr. C. F. Richards, managing director of Morphy-Richards, Ltd., at which a panel of seven export managers of companies represented on the B.E.A.M.A. Domestic Appliances Divisional Export Committee will answer questions from the audience.

Standards Engineers

A NEW publication by the British Standards Institution provides a guide to the principles and practice of applying standards in the individual firm. The booklet, "The Operation of a Company Standards Department," could have been subtitled "How to be a Standards Engineer." It is primarily addressed to the engineer who has been delegated to set up a standards department. It is hoped that it will also be of use to management, colleges and the established standards engineer. The booklet is sponsored by a joint committee of the B.S.I. and the Institution of Production Engineers and the draft was presented to the last standards conference for comment.

The booklet describes the functions of a company standards department and an outline is given of the fields covered by company standards and variety reduction. Advice is given on the actual writing of company standards and the means of making these standards effective. The importance of classification and coding in standards work is explained and the general principles are outlined. The layout and headings for a model standards sheet are outlined.

Copies of this booklet (Ref. No. PD 3542) can be obtained from the British Standards Institution, 2, Park Street, London, W.1, price 3s. It will also be on sale by H.M. Stationery Office.

WORK OF THE E.A.W.

A LECTURE describing the history and activities of the Electrical Association for Women was given by Miss Mary George, the director, at a meeting of the Association of Supervising Electrical Engineers in London on Tuesday. Miss George said that the first branch was formed in Glasgow in 1925, followed shortly afterwards by Birmingham and Manchester. Today there were nearly 200 branches.

Very soon the E.A.W. extended its work into the realm of formal education and attention was directed towards the need for establishing some definite standards of knowledge and qualifications for electrical demonstrators. This was followed by the institution of the Certificate and Diploma in Electrical Housecraft for teachers and further educational development, in 1936, when the Home Workers' Course was introduced for housewives, domestic helps and students.

Miss George went on to describe the London headquarters of the Association and its activities. Participation in exhibitions and agricultural shows was also an important part of its work, she said, and she expressed her appreciation of the help that the Association received from Electricity Boards and various other bodies at these times. Miss George paid a tribute to the work of the late Dame Caroline Haslett, the Association's first director, and concluded her address with a brief summary of the E.A.W.'s aims—to interest and educate women in the domestic use of electricity and to create an informed body of opinion on the subject; to encourage the teaching of electrical housecraft in schools; and to express the woman's point of view on the design and performance of electrical equipment.

Two-Speed Single-Winding Induction Motor

GENERALISED POLE-AMPLITUDE MODULATION

By G. H. RAWCLIFFE, M.A., D.Sc., M.I.E.E.*

Development of a new method of changing the speed of induction motors by pole-amplitude modulation is described. Winding methods additional to those described in an I.E.E. paper 18 months ago have been devised giving a considerable increase in power rating in the modulated connection. This article is based on a lecture given to the Rugby Sub-Centre of the Institution of Electrical Engineers

IN August, 1958, the present writer with two colleagues published a paper in the *Proceedings* of the Institution of Electrical Engineers which described the prototype form of a new type of two-speed single-winding squirrel-cage induction motor. This speed-changing method, which was given the name "pole-amplitude modulation," consists in applying a space variation to the amplitude of a polyphase winding. An abstract version of the paper was published in the *Electrical Review* of 22nd August, 1958, which concluded that the method had been shown to be applicable only to certain combinations of pole numbers, but that it was known to be possible to extend it to a greater variety of such combinations. It was hoped that the method, when fully developed, would provide a simple two-speed squirrel-cage induction motor, with one cheap and simple winding, which could be run efficiently near to any two synchronous speeds which might be selected.

Speed Ratios Available

The extension and generalisation of the method has now been achieved with complete success. The speed ratio of the prototype machine was 750/600 r.p.m., there being one stator winding for 8/10 poles. This was one of the pole ratios originally shown to be comformable with the new method, but it is now possible to obtain a two-speed single-winding squirrel-cage induction motor for any one of the complete series of pole combinations, 4/6; 6/8; 8/10; 10/12 . . . etc., and also for the complete series 10/14; 14/18; 18/22; 22/26 . . . etc. Obviously, there are multiple repetitions of any of these ratios, for example, 12/16 poles is simply 6/8 poles repeated twice around the perimeter of the machine. In fact, any combination of pole numbers can now be readily obtained by this method, provided the speed and pole ratios do not exceed 1·5 to 1.

It will be recalled that the basis of the method is to modulate the amplitude (A) of the m.m.f. wave (M_θ) of a winding of 2p poles, which can be represented by $M_\theta = A \sin p\theta$, in such a way that $A = C \sin k\theta$, where C is a constant and k is any whole number. Thus,

$$M_\theta = C \sin k\theta \sin p\theta$$
$$= \frac{C}{2}\left[\cos (p-k)\theta - \cos (p+k)\theta\right]$$

The three equations for the three phase windings are combined in such a way that one of the two terms in the bracket vanishes for each winding and one rotating field, either of (p−k) poles or of (p+k) poles, is left.

The theory of polyphase windings is always a recondite subject and the full theory of these special windings obviously cannot be treated here. It ought, however, to be added that, though the theory of these windings is difficult, their manufacture is very simple, which is an added merit of the new motors.

Control Gear

In the original I.E.E. paper and the *Electrical Review* article, it was shown that, for the first motor, only six control leads and a very simple type of control gear were required. All pole ratios can be covered by one or other of the two basic circuit arrangements shown in Fig. 1 and only six control leads are required in either case.

The type of controller is independent of the pole ratio, which is a substantial advantage as it makes for standardisation. A controller of a given current rating can be used to start a two-speed motor of any speed ratio and, indeed, the controller is identical with that which is needed for the conventional 2 to 1 pole changing, and is therefore already in standard production. No doubt an increased demand for such controllers will lead to the development of a type suitable for cheap repetition manufacture.

Increasing or Decreasing Pole Numbers

In the I.E.E. paper of August, 1958, it was stated that there exists "a reciprocal principle in pole-amplitude modulation," by which it is always possible either to start with a winding of p_1 poles and to modulate it to p_2 poles, where p_2 is greater than p_1; or to start with a winding of p_2 poles and modulate it to p_1 poles. In the original winding, the number of coil groups is always equal to the number of poles. Since the winding factor, and thus the power rating, of a winding after modulation are usually somewhat less than before modulation, it was said in the I.E.E. paper that one would normally use modulation to increase the pole number and to reduce the speed, rather than the other way round. This would be the preferred method where the load torque falls rapidly with fall of speed, such as a fan. Generally, the greatest possible output is obtained in the normal unmodulated condition and some deterioration in rating at the lower speed after modulation must be expected.

It has, however, been found that modulation to reduce the pole number and increase the speed usually gives the best overall power rating and performance, taking the two speeds together. The rating is slightly reduced for the lower pole number and higher speed, but far more than proportionately is gained for the higher pole number and lower speed. Modulation to reduce the pole number

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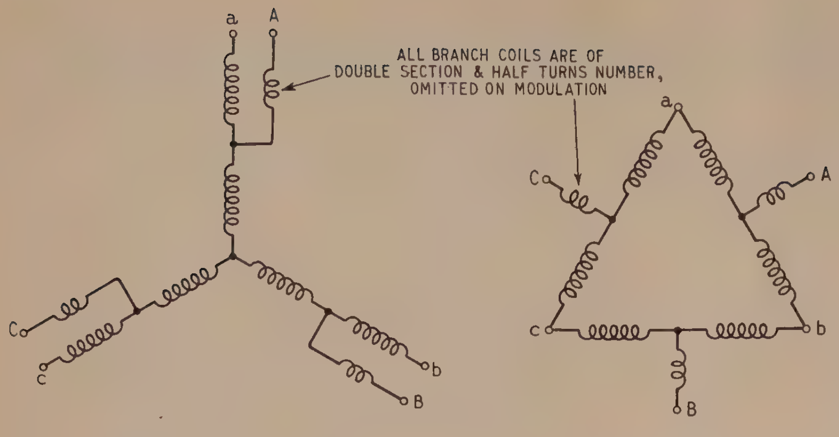

a
A
ALL BRANCH COILS ARE OF DOUBLE SECTION & HALF TURNS NUMBER, OMITTED ON MODULATION
C
c
b
B
a
C
A
c
b
B

PARALLEL STAR / SERIES STAR
UNMODULATED / MODULATED

PARALLEL STAR / SERIES DELTA
UNMODULATED / MODULATED

Fig. 1.—The two basic types of connection for induction motors using pole-amplitude modulation

p poles { Supply A B C / Join a b c   (p ± 2) poles { Supply a b c / Isolate A B C

In designs where no coils are to be omitted on modulation, the terminals A, B and C are the centre points of the three main phase windings

is likely to be the best alternative when something like a constant-torque drive is required, whereas modulation to increase the pole number is more suited to a fan or pump drive. The reciprocal principle in pole-amplitude modulation is therefore of practical importance and is not merely an interesting idea, as was thought when the I.E.E. paper was written; and modulation is equally likely to be used either to increase or to decrease the pole number of the original winding.

First Type of Modulated Winding

In the original form of pole-amplitude modulation, the process of modulation is carried out by reversal of the second half of each phase winding with respect to the first half, together with the omission of certain coils from each half phase winding. The conductors which are removed on modulation are so chosen that those which remain in circuit in each phase winding have a space distribution around the perimeter which follows one cycle of a sinusoidal law. Simple reversal of the remaining conductors is then equivalent to modulation of the amplitude of the original m.m.f. wave by one cycle of a sine wave.

The original winding is of standard integral-slot type and the only restriction imposed upon it is that the coil pitch must have some particular value. This requirement arises from the need to exclude certain harmonics. Since this coil pitch is commonly one which might well have been used anyway, the restriction is almost nominal and a two-speed motor of the original form is a standard single-speed motor in the unmodulated connection, normally for the higher speed. The output power, the efficiency and the power factor necessarily have the usual single-speed values at this speed.

In Fig. 1 of the original *Electrical Review* article, a prototype method of sinusoidal modulation was illustrated, but a developed method is shown here in Fig. 2. In this example, an eight-pole three-phase winding is wound in 48 slots, the coil grouping per phase thus being 2-2-2-2—2-2-2-2. On modulation, certain coils are omitted from circuit, as explained in the legend below Fig. 2, and the second half of each phase winding is reversed, with respect to the first half. The coil grouping of this machine after modulation can be represented as 01-2-2-10—(reverse)—01-2-2-10, where "0" represents a coil left out of circuit. The modulating wave shown in Fig. 2 expresses the effect of this omission and reversal of coils, and the resultant m.m.f. wave for each phase winding (a wave of 6 poles and 10 poles mixed) is given at the bottom of the figure. (It is possible so to combine the three phase windings that the individual fields of 6 poles disappear, and the resultant is a pure 10-pole rotating field.) It will be seen that the modulating wave is a close approximation to sinusoidal modulation, which is the theoretical ideal.

On modulation, some portion of the winding (one-quarter in this case) is omitted and the effectiveness of the remaining conductors may be slightly reduced, giving a lower overall winding factor. This lowers the rating of the motor correspondingly, but the efficiency and power factor are only slightly affected. The reduction in efficiency arises from a reduction in load and not from any increase in losses: generally, these are rather lower after modulation, but are not reduced enough to maintain the efficiency unaltered at the reduced loading.

This original method of pole-amplitude modulation is excellent for fan and pump drives and other applications with similar torque characteristics, where the power demanded falls off rapidly with reduction of speed. In general, power factors and efficiencies are better than can be obtained from the only alternative type of two-speed motor, which is one with two completely separate windings. At one speed, the power factor and efficiency are equal to the best single-speed values: at the other, they are only slightly inferior to the corresponding single-speed quantities. The power rating at the lower speed will usually be about 70 per cent of the rating of a machine wound with a single-speed winding for this lower speed.

Second Type of Modulated Winding

The successful use of modulated windings from which certain coils had been omitted, led to a consideration of the possibility that the initial distribution of conductors need not be uniform and that, instead, the original coil grouping of each phase winding might be quasi-sinusoidal. According to this concept, a quasi-fractional-slot coil distribution would be imposed on the original winding, even when the average number of slots per pole per phase was integral. For example, the coil grouping of each phase in an eight-pole winding wound in 72 slots (equal to three slots per pole per phase) would normally be 3-3-3-3—3-3-3-3; whereas in a winding for the second type of pole-amplitude modulation the coils of one phase winding would initially be grouped 2-4-4-2—2-4-4-2. Simple reversal of the second half of each phase winding with respect to the first would effect modulation to 10 poles. The complete winding would be in circuit at both speeds.

The eight-pole winding considered above, as an example of the original type of modulated winding, would be modified, under these later proposals, to give an initial coil grouping of 1-2-2-1—1-2-2-1, the winding being embodied in 36 slots, instead of 48 slots. A different stator would, of course, be used and there is no question of leaving vacant 12 slots out of 48. This last winding

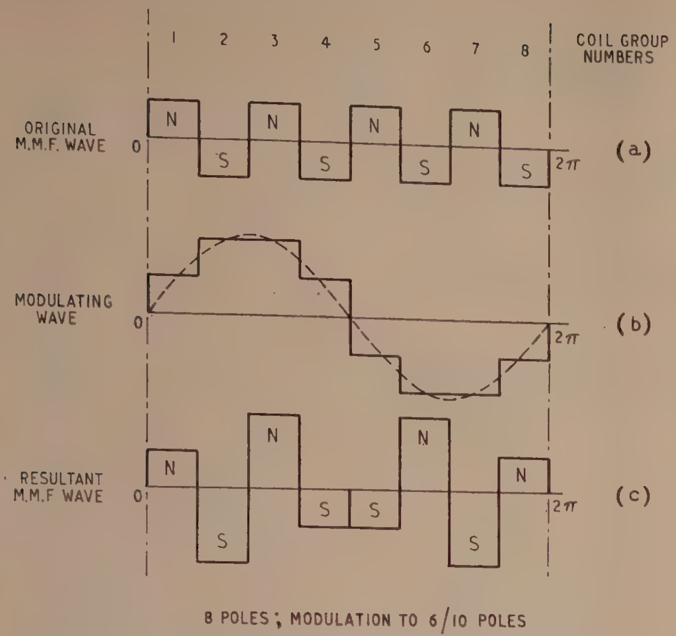


Fig. 2.—Pole-amplitude modulation by a nearly-sinusoidal wave

To modulate, reverse groups 5, 6, 7 and 8 with respect to groups 1, 2, 3 and 4, omitting half the coils in groups 1, 4, 5 and 8. Omit the coils nearest to the zero points of the modulating wave

is inherently a fractional-slot winding, of 1½ slots per pole per phase, but the normal coil grouping would be 1-2-1-2—1-2-1-2, if the machine were not intended for pole-amplitude modulation, and the winding can still fairly be called a quasi-fractional-slot winding.

The difference between the two types of modulation may be summarised by saying that the earlier type applies sinusoidal modulation to a winding of linear distribution, whereas the later type applies rectangular modulation to a winding of sinusoidal distribution. The basic principle of rectangular modulation is shown in Fig. 3 and it will be observed that the resultant modulated m.m.f. wave is of the same shape as that shown in Fig. 2 for the earlier type of modulation.

The real advantage of the later type of modulation cannot, however, be represented in Fig. 3, but the amplitude of the resultant m.m.f. wave is necessarily greater when no conductors have been omitted from circuit on modulation. This second type of modulation compared with the original type normally gives considerable increase in power rating in the modulated connection, at the price of a small reduction in rating in the unmodulated connection. Approximately 85 per cent to 90 per cent of normal rating for a single-speed winding will usually be obtained at both speeds, as has been verified by a number of tests. For a duty where the torque does not vary rapidly with speed, and where broadly-constant torque is required, this second form of modulation will be preferred.

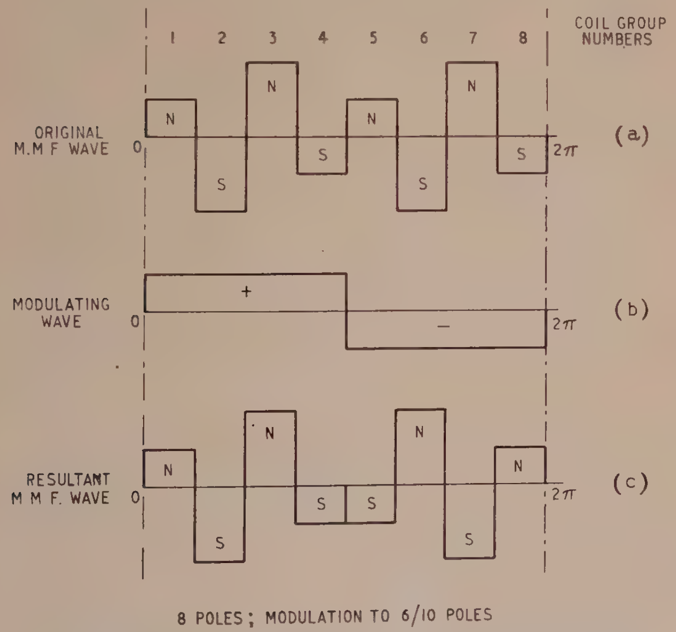


Fig. 3.—Pole-amplitude modulation of an irregular fractional-slot winding

To modulate, reverse coil groups 5, 6, 7 and 8 with respect to coil groups 1, 2, 3 and 4. Original coil grouping 1-2-2-1—1-2-2-1

Conclusion

The original method of pole-amplitude modulation suffers from a 30 per cent reduction in motor rating when in the modulated condition. The second method has the same relative rating, compared with a single-speed machine, whether in the modulated or unmodulated condition, this rating being about 12 per cent lower than that of an equivalent single-speed machine. Thus, the original method is better applied to fans where the modulation reduces the speed (and rating) and the second method is applicable to constant-torque drives.

It has been estimated that about 3 per cent of all the squirrel-cage induction motors made (at least excluding machines below 10 h.p.) are at present wound with two or more independent windings. This is a small proportion, but a very large number for such a widely-used type of motor. Thus, in this considerable number of cases, the demand is so insistent that the user is prepared to face the extra cost, size, weight and complexity. It is believed that if the advantages of a changeable speed were available without the disadvantages, and at a more moderate cost, a number of users who at present tolerate a fixed speed for some application would be glad of a chance to vary it. In short, it is believed that the motor will create its own demand. Further, it is clear that a squirrel-cage motor with two independent windings can now be made to give four speeds, with considerable freedom in relation to the choice of speeds. This makes available the possibility of using a multi-speed squirrel-cage motor, instead of a motor of continuously variable speed, for many applications.

This method of speed changing has been extensively tested on a number of experimental machines, up to many hundreds of horsepower and for various speed ratios, by several important industrial companies who are interested, in particular by Associated Electrical Industries, Ltd. It has proved a complete success in every respect: everything claimed has been achieved and none of the troubles forecast has occurred. It ought perhaps to be stated that the performance for 4/6 poles is marginally inferior to that for other pole ratios, but not seriously so and improvements are still likely to be made. Particular attention has been paid to noise observations against a quiet background, and to dynamic speed-torque tests. The companies concerned are ready to manufacture two-speed single-winding squirrel-cage induction motors of any size, and any speed ratio up to 1·5 to 1, to customers' orders. Detailed development, to obtain even better performance, is still proceeding, especially in relation to the less common pole ratios, but the method has already reached normal industrial standards of performance.

The patent rights in this invention are held by the National Research Development Corporation, but they are not prepared at the present time to entertain further applications for licences to manufacture.

VIEWS on the NEWS

By REFLECTOR

Now that so many women are at work during the day there are a large number of fruitless visits by meter readers who have to leave cards upon which the consumers are asked to enter their meter readings. Although these cards illustrate the dials and all that is necessary is to indicate the position of each pointer, many people are quite incapable of completing the cards accurately. Cyclometer type meters, as I have said before, would make the consumer's task an easier one. I see that Alderman J. Bennett, chairman of the Eastern Electricity Consultative Council, agrees with this and his Council is asking the Eastern Electricity Board to consider the introduction of cyclometer meters.

* * *

Mr. W. Hawthorn, of Scarborough, Ontario, revives the subject of special kettles and lighting fittings which was dealt with in this page some weeks ago. He sends me a pamphlet produced by the Canadian General Electric Co., Ltd., which illustrates and describes a kettle with dual control. On the "Boil" setting the kettle will send out the usual cloud of vapour when boiling point is reached, but on turning the control knob to "Vap" the water is kept "at a gentle boil with a minimum of vapour." The same company has also produced for many years a "Tri-light" lamp which has two filaments (200 W and 100 W) controlled by a four-position switch giving three degrees of illumination.

* * *

A report of a council meeting in the *Ilford Recorder* contains the following passage:—

> "After Mr. E. . . ., Dagenham, had complained to the Electricity Council's Essex Local Committee that his supply would not take a washing machine with a heater, a £1 million re-wiring plan for the L.C.C.'s Becontree Estate was announced."

Cause and effect?

* * *

The *Guardian* of 14th January reported that:—

> "Mr. Justice Roxburgh rose early in his Chancery Court yesterday because the electric lighting failed. Postponing the hearing of cases on his list, he announced that the appropriate department had informed him that certain wiring was suffering from the infirmities of old age and could not be repaired that day."

An example of the law's delays in putting its own house in order.

* * *

Much as we may dislike modern slang one must be aware of it in order to avoid using it innocently in a wrong sense. For instance, I find in an electrical manufacturing company's magazine a report of a staff dinner. One of the speakers proposed the toast of the company and gave some particulars of its activities. He said that he had been asked recently if he thought the company had turned the corner. He replied that it was difficult to tell, but the company was certainly "round the bend."

* * *

I have just got hold of the Christmas number of the "Tatec Times," produced for the staff of the Trinidad and Tobago Electricity Commission of which Mr. K. W. Finch (formerly manager of the Cheltenham District of the Midlands Electricity Board) is general manager. In it is an article by Mr. K. F. Scheult which contains the following paragraph:—

> "In a dry goods store if a man pays for a shirt and gets a handkerchief you would not be surprised if he complained. In our business if a customer pays for 115 volts and gets 80 he has every right to complain, and if he pays for a service of 24 hours and gets 23 he also has a right to complain. A customer has a right to expect a continuous supply of electricity at the right voltage, to courteous treatment at all times (even when he is being a bit difficult) and to get his service promptly reconnected after he has paid his arrears."

This is a counsel of perfection in some circumstances, often beyond the control of the supply authority. The latter part of this suggests that consumers are no more perfect in the West Indies than they are here.

* * *

Reductions in the length of the working week in sections of industry seem likely to cause complications. The *Eastern Evening News* says that the Executive Committee of the Norwich City Council has confirmed a reduction in the weekly hours of eight men in the street lighting section from 44 to 42, with the same basic pay. The report goes on:—

> "These men were former employees of the Eastern Electricity Board and by agreement were benefiting from new conditions laid down by the J.I.C. for the Electricity Supply Industry. This agreement did not affect two men since taken on by the Council in the same department and they would continue to work 44 hours."

A member of the Committee said it was on the cards that the two men's union would apply for the shorter week. And then?

* * *

Sixty years ago the Boer War was in progress. Unlike succeeding wars, its impact upon the country was such as to merit only a column in the *Electrical Review* of 26th January, 1900. This was described as "quite a batch of notices":—

> "First in importance is the announcement that the services of 150 of Major Crompton's electrical volunteers have been accepted by the War Office, and that £3,000 is to be allowed for the provision of apparatus for use at the front."

COMPUTER RELIABILITY AND MAINTENANCE

DISCUSSION meetings on the reliability and maintenance of digital computer systems from both managerial and engineering aspects were held at the Institution of Electrical Engineers this week, under the ægis of the British Conference on Automation and Computation. The proceedings were opened by Sir Willis Jackson, President of the I.E.E., and the first three sessions were organised by the British Computer Society, Ltd.

In the first session the operational logging and recording techniques used in Government automatic data-processing installations and the provisional deductions from results so far obtained were discussed by J. H. H. Merriman and C. W. Mortby. Electronic computers were being introduced into Government Departments as part of a planned programme of office mechanisation and by 1961 there would be nearly 20 systems in use, comprising 13 types from eight manufacturers. Strict control of these installations was necessary and techniques had to be worked out to collect information on performance and reliability.

Management and organisational problems in ensuring machine serviceability were then dealt with by C. P. H. Marks. Adequate time for data processing, checking both machine and programmes, breakdowns and re-running work which may be spoilt or suspect because of machine faults or errors in data must be allowed. In a paper on experience with organisational problems in a business computer installation, H. E. C. Nash referred to experiences with the organisation of a business installation using a National-Elliott 405 computer. Methods for detecting either residual errors on tapes or errors from faulty tape reading, together with the organisation of the operating staff for the rapid correction of tape errors, was described.

Programming and Fault Diagnosis

The second session considered improving reliability by programming strategy. A lecture by L. Fox and J. S. Rollett on checking in electronic computation discussed the types of errors which might arise through human errors in supplying the data, poor or inaccurate methods of solution, and machine errors in input, during computation, and in output, particularly for scientific problems.

Programming strategy for protection against computer and operator errors in business programmes using large files of data contained on magnetic tapes was dealt with by P. M. Hunt, while a lecture on programming techniques for protection against computer and operator/user errors was delivered by B. R. Tozer.

The third session was devoted to maintenance and fault-diagnostic techniques. Some engineering factors of importance in relation to reliability of Government automatic data-processing systems were covered by J. W. Freebody and K. M. Heron. The rapid development and exploitation of digital computers had brought initial troubles and reliability problems. The settling-down period in service was frequently prolonged by deficiencies in equipment design or inadequate testing of equipment before hand-over. Standards of performance, in general, were not sufficiently high, and marked improvement was particularly necessary on some items of peripheral equipment—high-speed printers and card readers were quoted as examples.

R. P. Gibson and E. H. Lenaerts considered that a high standard of preventive maintenance was essential if the strictly scheduled operational work was not to be upset by computer breakdowns. If components which were deteriorating towards the failure point were detected and realised before operational failure occurred, at least 95 per cent of the operational time would be free from technical troubles. The DEUCE computer, which had been in service for about four years, was referred to by J. W. A. Richardson in his contribution on systematic detailed recording of circuit safety margins as an aid to computer maintenance.

System Reliability

The first of the three sessions organised by the Institution of Electrical Engineers concerned experience of system reliability. In his paper on component reliability, G. W. A. Dummer said that the reliability of any computer depended largely on the failure rate of its components. The probable failure rates of common components under laboratory conditions included capacitors 0·1 per cent, fuses and circuit-breakers 0·3 per cent, gyros 5 per cent, meters 3 per cent, potentiometers 0·5 per cent, relays 1·5 per cent, switches and thermostats 0·5 per cent, transformers 0·2-0·8 per cent and valves 1-2 per cent.

The relative importance of reliability and accuracy for different types of system was dealt with by E. P. G. Wright and A. Y. Cooper. The reliability of an equipment was measured by the proportion of its scheduled working hours during which it was actually in service, whereas the accuracy must be decided by the likelihood of errors during a period of time or in relation to an amount of work carried out.

The marginal-testing techniques, discussed by J. P. Bunt, were used in two spheres of digital-computer engineering: to establish optimum design conditions, to maximise the reliability of the equipment and as an aid in finding faults during maintenance. Experience showed that for a valve computer a reliability of 90-99 per cent could be achieved over short periods and that marginal testing might be vital in attaining this performance. Errors indicated impending breakdown, and marginal-testing techniques could be used to attain the highest standards of performance.

The fifth session was concerned with the influence of engineering design on reliability. Some factors affecting reliability were given by A. A. Robinson and R. E. Hodgkinson. The constant demand for higher speeds and improved facilities introduced complications, but standardisation and simplicity were helpful in solving this problem. Plug-in unit construction improved accessibility and permitted off-line servicing and simplified the identification of faults.

The influence of computer design on reliability and maintenance was the topic discussed by P. H. U. Maguire. The requirements that a machine should be reliable and easy to maintain were often conflicting, in that increased reliability could often be achieved only by the use of redundant logic, such as parallel paths and parity checks. These would reduce the probability of error, at the expense of increased complexity, resulting in increased maintenance time in the event of error. Simplicity of design was becoming the most important criterion, and it was here that the parallel machine offered advantages over the serial type.

The application of statistics to the design and production of electronic units, dealt with by A. Kruithof, would, if the requisite statistical and cost information on components was available, and if this information was properly processed, lead either to minimum cost for a given reliability or to maximum reliability at a given cost. A full statistical analysis of the design and production of an electronic unit was desirable when mass production was envisaged, but a less-thorough approach would still result in more reliable circuits or lower cost. A detraction from the analysis was the lack of statistical information on components.

G. W. Monk and N. E. Wiseman discussed some of the factors involved in the design of a reliable system of two-state d.c. circuits for digital computing and indicated the manner in which many parameters might be dealt with using digital-computing techniques. In general, the structure of a parameter defined three conditions, where the circuit would not work in the required mode, where it would work with restricted tolerance, and where the tolerance available was greater than the normal safe operational requirements.

The final session was concerned with factors affecting the reliability of peripheral equipment. D. W. Willis dealt with the reliability of magnetic-tape systems. Potential users were acquiring confidence as a result of the operational successes of the early magnetic-tape and film units. The reliability of tape was related to the performance demanded. Some techniques used in improving the reliability of input and output equipment were outlined by C. C. Jones. Since 150 character-selection mechanisms might be fitted into a space whose overall width could be only 15in, the component parts were of thin cross-section and the stresses resulting from intermittently high-speed movement were conducive to fatigue fractures.

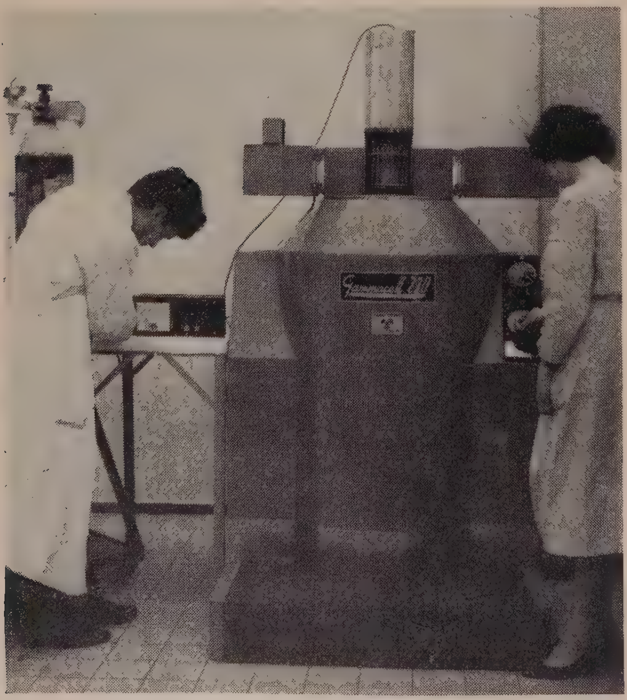
Finally, F. W. Pearson considered factors affecting the reliability of peripheral equipment, which were mainly mechanical and linked the human being and the computing system. Each machine comprised a number of similar logical mechanisms, designed to act on instructions received either directly from a human being or from the computing system, and reliability could not be achieved unless these instructions were precise and accurate.

Irradiation Cell

A GAMMA-RAY irradiation cell, suitable for laboratory experiments and small-scale radiation processing, is being produced by the Atomic Energy of Canada, Ltd., and is marketed in this country by Watson & Sons (Electro-Medical), Ltd., East Lane, North Wembley, Middlesex. Some investigations for which the gamma cell is suitable are irradiation of plastics, sterilisation and the preservation of food. The unit is self-contained and operation is simple. Remote handling is not necessary and the external radiation field is very low.

The radiation source consists of a ring of cobalt-60 rods, mounted around a stainless steel cylinder which is embedded in a shielding block. The cylindrical sample chamber, 6in in diameter by 8½in high, is loaded and unloaded above the source, into which it is moved by a motor. The irradiation dose rate with a 1,100 curie source is approximately 10^5 röntgens per hour. The maximum source strength will depend on working conditions near the cell and will be between 13,000 and 30,000 curies, giving a maximum dose rate of about 2×10^6 röntgens per hour.

Samples may be irradiated for a pre-set time, adjustable between 18 minutes and 120 hours, and the remaining irradiation time is indicated, if for any reason irradiation is stopped before the desired time is completed. Four ducts connected to the sample chamber allow the entry of pipes carrying liquids or gases and wiring, thus enabling irradiation in a controlled atmosphere to be achieved. The overall dimensions of the whole approximately cylindrical unit are 40in by 60in by 77in high and the weight is 7,600 lb.


Gamma cell irradiation equipment

SHIP LIGHTING

A PAPER on various aspects of ship lighting was presented by Mr. J. T. Grundy in company with Mr. C. H. Vaughan at a meeting of the Illuminating Engineering Society held at the Royal Society of Arts on 12th January. It was pointed out that the current rules and regulations for the electrical equipment of ships dealt largely with electrical and mechanical construction and safety as distinct from illuminating engineering. Although navigational lighting equipment had not kept pace with modern practice in such other fields as railway signalling, there were more collisions by day than by night.

The requirements of vessels for the Royal Navy were contrasted with those of Merchant Navy vessels and the latter's needs in various activities were underlined. These included the lighting of cargo spaces and crew and passenger accommodation. In correlating all these factors, attention was drawn to the vital necessity of colour rendering and the avoidance of glare. On tankers flameproof fittings and other special lamps were required. A detailed consideration of discharge lighting in ships, incorporating both a.c. and d.c. systems, was given. In discussing future trends, comment was made on the inadequacy of research on ships' lighting compared with the large expenditure planned for other marine research projects.

INDUSTRIAL NEWS

Are Price Reductions Possible ?

Some difficulties confronting manufacturers who are anxious to reduce prices, or at least to prevent them from rising, are set out in a memorandum sent by Mr. W. H. McFadzean, president of the Federation of British Industries, to the Chancellor of the Exchequer. While recognising that all sections of industry and commerce share with the Government responsibility for making an effective contribution to stable prices, Mr. McFadzean points out that manufacturers' goods account for a part only of the index of retail prices and manufacturers' costs are not wholly within their own control.

Whatever views may be held as to what relative proportions of outside and retained capital should be invested in an expanding business, part of the proceeds of the sales of products must be reserved for research and development of techniques and markets at home and abroad. There can be no question of "freezing" wages, prices or profits. Each company must determine its prices according to its assessment of the costs, of competition and of the long-term interests of its own business and of the country as a whole.

Mr. McFadzean emphasises that, given a general recognition of these facts, members of the F.B.I. will wish to do everything in their power to help to maintain a generally stable level of prices. Indeed, many manufacturers have recently reduced their prices and a greater number have held prices stable or improved their products in spite of increased costs.

Export Prospects

According to the January issue of the *G.E.C. Export Guide* the prospects for British exports are good or improving in 32 out of the 34 countries surveyed. There are no major markets where prospects have changed for the worse since October and only in Iraq and Venezuela does the outlook continue to be poor.

Two special articles deal with "Aid for Multilateral Trade" and "Reappraising Canadian Trading Opportunities." It is maintained that the time has come for Britain to take a lead in urging a wider sharing of the burden of aid with the United States. Contributions, on the basis of national income per head, should be made on a scale approaching that of the United States. "The long-term benefits, both to Britain's trade and the general rate of economic growth, would be greater than any immediate burden incurred." On Canada, the *Guide* states that current prosperity has set up a strong demand for imports. Though hopes of a larger British share in Canadian imports have so far been disappointed, "the fact remains that Canada presents a promising market for the British exporter if he can satisfy the country's particular demands."

Electricity Supply Wages

The claim for a substantial increase in wages for all manual workers in the electricity supply industry was submitted by the trade union side at a meeting of the N.J.I.C. on 21st January. The claim is based on the increase in retail prices; the lack of response to the Government's entreaties to manufacturers and traders to reduce prices; the lower earnings of supply workers compared with earnings in other industries; the increased differential between craftsmen and the lower grades in the National Joint Board Schedule; and the absence of any contribution towards the realisation of the Government's promise to double the standard of living within twenty-five years.

Instrument Exhibition in Russia

As a result of the report to the Council by the three-man delegation of the Scientific Instrument Manufacturers' Association of Great Britain, which went to Moscow at the beginning of November, and with the support from thirty members of S.I.M.A., an exhibition of British scientific instruments will be held in Moscow from 16th to 26th June next.

Australian Rolling Mill Orders

Orders valued at nearly £700,000 for electrical equipment for Australian rolling mills have been obtained by the A.E.I. Heavy Plant Division, Rugby, from Australian Electrical Industries Pty., Ltd. The largest order is for drives for a new 5-stand tandem cold strip mill which will roll wide strip at a maximum speed of 5,000ft a minute. Motors with a total output of 20,750 h.p. will drive the mill and its tension reel, and the generators supplying d.c. to the motors will be driven by two 10,000 h.p., 750 r.p.m. synchronous motors. Stand 1 will be driven by a single-unit 2,000 h.p. motor; stands 2, 3 and 4 each by a double-unit 4,000 h.p. motor; stand 5 by a triple-unit 5,500 h.p. motor; and the tension reel by a triple-unit 1,250 h.p. motor. Most of the control equipment for this mill will be manufactured in Australia to suit the control scheme designed by the Heavy Plant Division engineers, but "Magnestats" (magnetic amplifiers) supervisory control panel, high-speed circuit-breakers, and rheostats are being supplied from Britain.

Of the other two orders, one is for a 1,000 h.p. d.c. motor for driving an additional stand for an existing merchant mill, and the other is for a 500 h.p. d.c. motor with grid-controlled mercury-arc rectifier, to drive an edger stand which is being added to an existing billet mill.

Readership Survey

There has already been an encouraging response, augmented with every post, to our request for the completion of the questionnaire included in last week's issue. As we are anxious to make this readership survey as thorough as possible we ask those who have not yet returned the form to do so immediately. If a reader finds that a questionnaire has been removed from the copy he sees we will send him another upon request.

English Electric's Protest

Reuter reports from New York that the English Electric Co. has lodged a protest with the U.S. Bureau of Reclamation against the bid of an American concern for eight water turbines for the Glen Canyon Dam, Arizona. The English Electric Co. put in a tender for $6,214,550, which was the lowest offer, the second lowest being that of the Baldwin-Lima-Hamilton Corporation ($6,392,000). This would have qualified the American company to succeed under the Buy American Act, which allows a 6 per cent differential in favour of American manufacturers. But the English Electric Co. contends that the American bid was for plant that would involve work by a Belgian concern to the extent of 50 per cent.

Mobile Exhibition

Calidec, Ltd., has organised a travelling exhibition for the purpose of demonstrating its floor-warming and soil-warming systems. Arrangements have been made with British Railways for the conversion of a railway coach for use over a period of two weeks. The coach will be equipped with the Calidec floor-warming system at one end and the soil-warming system at the other, and will visit various centres to a pre-arranged schedule. Invitations are being sent to architects, electrical contractors and others.

Plastics Industry Education Fund

The trustees of the above-mentioned fund have awarded training grants to 18 students following full-time courses. In addition, the following annual scholarships have been granted or renewed:—Diploma in Technology (four years' sandwich course): Borough Polytechnic (four at £150); Brunel College of Technology (five at £175); and College of Advanced Technology, Birmingham (six at £150). Associateships of the Plastics Institute (three years' full-time): National College of Rubber Technology (three at £300). Diploma of the Plastics Institute (two years' full-time): Borough Polytechnic (three at £100). Mr. A. G. Turner received an Associated Iliffe Press Fund Travel Scholarship for a three months' tour of Europe. Mr. C. S. Dingley, F.P.I., has been re-elected chairman of the trustees for a further year.

Atlas Lighting Design Course

More than fifty senior architects, consultants, electrical engineering contractors and works engineers are attending the first Atlas Lighting design course, which is being held in the Lecture Theatre of the new Thorn House showrooms. The course commenced on 6th January and continues for seven consecutive Wednesday evenings. Its object is to explain the basic principles and practical application of the technical data included in the Atlas Lighting catalogue. The lectures are being given by Mr. G. V. McNeill, A.M.I.E.E., Dip.M.I.E.S., of the Technical Sales Department of Atlas Lighting, Ltd., and his talks are supplemented by practical demonstrations of the range of equipment on display in the Thorn House showrooms.

Refrigerator Sales in November

The Domestic Refrigeration Development Committee states that sales of domestic refrigerators run by electricity, gas, bottled gas and paraffin during November reached a total of 56,596. Sales to the home market (50,095) increased by just under 100 per cent on the same month last year (25,555). Sales of domestic refrigerators for January-November inclusive were: 1958, 528,497; 1959, 889,505.

Titanium Booklets

The first of a series of five booklets being published by I.C.I., Ltd., Metals Division, covering the properties and uses of titanium is of a general introductory nature. It describes the company's manufacturing facilities and production range and indicates the principal outlets for the metal and its alloys. Titanium has a high strength/weight ratio and corrosion resistance. It can be readily anodised and the anodic film is an insulator except under mechanical pressure. Platinised titanium anodes produced by the company carry heavy anodic currents without harming the titanium, and such anodes — light, strong and resistant to erosion—offer the advantages of platinum at lower cost. Applications include industrial electrolytic cells and cathodic protection. The succeeding booklets will cover physical and mechanical properties, corrosion resistance, fabrication, and weight tables in greater detail.

E.C.A. Year Book

The 1959-60 edition of "The Electrical Contractors' Year Book" is now available from the Electrical Contractors' Association, 14, Bedford Row, London, W.C.1, price 25s net (27s 6d post free). All the usual features have been retained and in addition to the lists of members there are sections containing practically all the information which the electrical contractor is likely to require in conducting the non-technical side of his business.

Heat Treatment Plant Orders

A. P. Newall & Co., Ltd., Glasgow, manufacturers of "Hitensile" and "Newalloy" bolts and studs, have placed an order with the Electric Resistance Furnace Co., Ltd., for continuous, automatic, heat treatment plant for the hardening and tempering of nuts and bolts. The plant, which will be one of the largest bolt hardening and tempering installations in Britain, will include Efco cast-link and mesh belt conveyor furnaces, a quench tank and an endothermic atmosphere generator. The order is valued at £33,000. The Electric Resistance Furnace Co. has also received an order from the United Kingdom Atomic Energy Authority for furnaces for the heat treatment of nuclear fuel elements. The order, valued at over £15,000, covers the supply of six Efco-Lindberg furnaces fitted with external forced-convection heating units.

Napiers Still with English Electric

D. Napier & Son, Ltd., makers of aircraft engines, have announced that they will not be included in the English Electric-Vickers-Bristol Aircraft combine but will continue to operate independently within the English Electric group.

Elliott-Automation Acquisition

It is announced that the Elliott-Automation Group has widened the scope of its interests in control valves by the purchase for cash of Black Automatic Controls, Ltd., Corsham, Wilts., manufacturers of control valve and pressure regulating equipment.

Works Visit

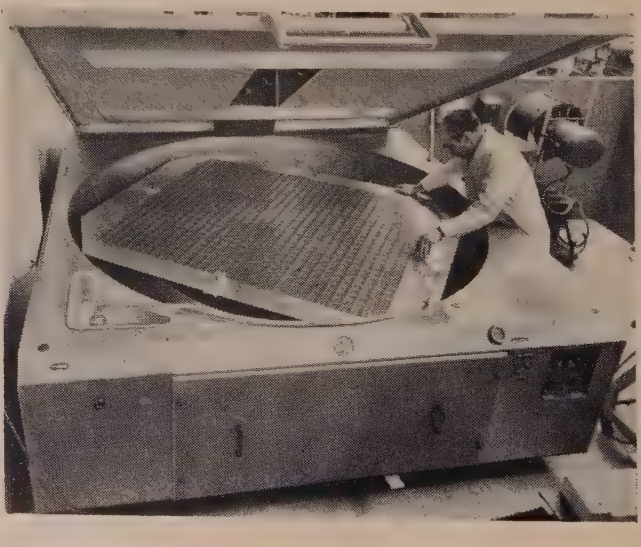
Chief Akitoye Coker, Commissioner for West Nigeria, accompanied by senior officials from his United Kingdom office, visited Johnson & Phillips, Ltd., Charlton, on 7th January, where the party were shown over the cable and transformer shops at Victoria Works. Later, the guests were entertained to luncheon by Mr. W. Glass, chairman of the company, and the directors, and afterwards continued their tour by visiting the J. & P. switchgear and capacitor factories at New Cross.

Guide to Broadcasting Stations

The twelfth edition of "Guide to Broadcasting Stations," compiled by the *Wireless World* and published by Iliffe & Sons, Ltd., Dorset House, Stamford Street, London, S.E.1, price 3s 6d net (by post 4s), is now available. In addition to the main sections listing all European long- and medium-wave broadcasting stations and

Two electromagnets, made at the Bedford Works of Brookhirst Igranic, Ltd., which have recently been shipped to India. Used in pairs, on a 30ft spreader bar, magnets of this type will lift up to 17 rails at a single hoist

Part of the automatic equipment recently installed in the Borehamwood factory of Printed Circuits, Ltd. (a company within the A.E.I. group) in which 1,100 separate circuits incorporating inductors are being processed on one 5ft by 5ft board



nearly 2,500 short-wave stations of the world, this edition includes a list of over 1,000 European v.h.f. sound broadcasting stations and another giving Europe's main television stations. The Guide has been considerably enlarged to accommodate a number of additional features giving useful information for the broadcast listener. These include standard time throughout the world, international allocation of call signs and a wavelength-frequency conversion table.

Electric Steelmaking

Following the recent statement of the United Steel Companies, Ltd., that they are to spend £10 million on installing what will be the largest electric steelmaking plant in the world at their Steel, Peech & Tozer branch, G.W.B. Furnaces, Ltd., announce that they are to supply the first two electric arc furnaces for the project.

These furnaces will be almost twice as large as any previously built in Great Britain, each having an electrical rating of 40 MVA. They will be of "Demag" design although, apart from the regulator, the equivalent of which is unobtainable in this country, the units will be entirely of British manufacture, the steel construction work being carried out by the United Steel subsidiary, Distington Engineering Co., Ltd.

Each furnace has an internal diameter of 24ft, a nominal capacity of 150 tons, and is capable of melting at the rate of one ton per minute. In practice, the furnaces will be used for a maximum of 110 tons ingot weight. The total output of the finished plant will be 1,350,000 ingot tons of steel a year. On completion of the scheme in five years' time, six electric arc furnaces will have replaced 21 open hearth furnaces and fourteen 120ft chimneys will have been demolished.

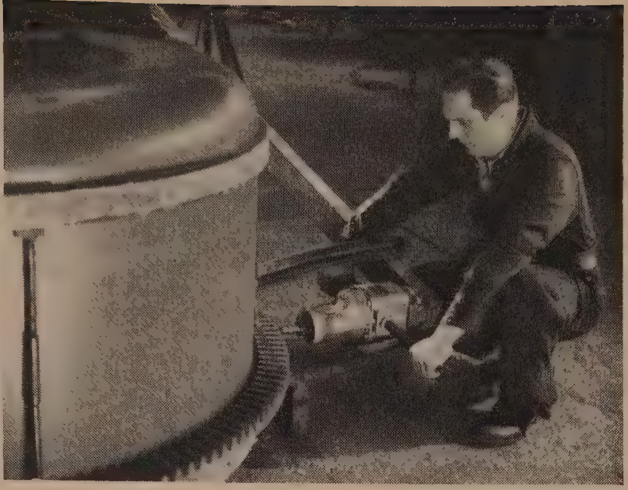
Order for Electronic Computer

The London & Manchester Assurance Co., Ltd., has placed an order with Ferranti, Ltd., for a £100,000 "Pegasus" electronic data-processing system. It is to be installed at the headquarters of the company in London in October next, and will be used in the first instance for their Ordinary Branch accounting and valuation work.

Power Tool Films

The variety of uses to which portable electric tools can be put in the home and in industry is effectively demonstrated in two new films shown in London last week by Wolf Electric Tools, Ltd. "One Jump Ahead," a simple story involving the T.V. commentator Mr. Raymond Baxter, is used to illustrate the ways in which four well-known engineering firms are using power tools on their production lines. It is shown that these tools can not only be used on unexpectedly heavy work but that savings are achieved because the tools are brought to the work and because several operators can work on a job simultaneously. Photographed in colour, the film is being shown at engineering centres throughout the country and copies will later be available on loan, free of charge.

A still from "One Jump Ahead" showing a portable tool being used for heavy duty drilling



The second film, "People Like Us," also in colour, shows how Wolf power tools can be the answer to many "do-it-yourself" problems, and gives much useful guidance on the way the tools should be used if the best results are to be obtained.

Selling Light

The South and South East Region of the British Lighting Council has arranged a course of three lectures for the staff of electrical contractors and others selling lighting equipment, to be held on Tuesdays, 26th January and 2nd and 9th February at Cook's Hotel, Old Steine, Brighton.

East Pakistan Radio-Telephone Installation

The Commissioners of the Port of Chittagong, East Pakistan, have placed an order with Marconi's Wireless Telegraph Co., Ltd., for the establishment of a v.h.f. radio-telephone network to improve ship-to-shore communications within the port area and the Kharnaphuli river. Besides the installation of duplicate v.h.f. transmitters and receivers in the shore stations at the Post Office and at the signal station at Juldia, the order also includes the supplying of mobile stations for use in two harbour tugs and a pilot launch.

Fish Factory Trawler

Fairtry III, the second of two 2,600-ton fish factory trawlers ordered by Chr. Salvesen & Co., Ltd., Leith, from Wm. Simons & Co., Ltd., Renfrew, was launched on 17th December last. Like her sister ship, *Fairtry II*, which was completed earlier in the year, the new vessel will have diesel-electric propulsion. The electrical equipment is being supplied by the General Electric Co., Ltd., including some thirty motors, totalling over 210 h.p., for operating the processing plant.

A combination of trawler, processing plant, deep-freezer and floating warehouse, the *Fairtry III* has a wide variety of auxiliary power requirements. The main propulsion motor is a double-armature machine rated at 2,000 s.h.p. with a maximum speed of 130 r.p.m., direct-coupled to the propeller shaft. Speed is controlled by varying the voltage across the armatures, which are connected in series. Direction of rotation is changed by reversing the polarity of the supply. In an emergency the motor can be made to run with only one armature in circuit.

Power is supplied to the motor by three generators, each rated at 535 kW, 400 V and driven at 435 r.p.m. by a 1,340 h.p. Ruston & Hornsby 5VQXZ five-cylinder diesel. Coupled in tandem with each main generator is a 270 kW, 220 V generator for supplying auxiliary equipment. The three main generators are connected in series, giving a total of 1,200 V—or 600 V across each of the two motor armatures. Output voltage is controlled by varying the excitation of the main generators.

Polythene Production

The I.C.I. Plastics Division is to increase polythene production by approximately 15 per cent in 1960, bringing the annual output to about 105,000 tons. The supply position will be further improved by re-deployment of total sales. As a result of the completion of new I.C.I. plants in India and Australia, and increased production in France and Germany, more polythene will be available for home distribution.

Polish Railway Electrification

The first equipment under a £2¾ million railway electrification contract awarded through the Polish Government agency, Elektrim, has been dispatched by British Insulated Callender's Construction Co., Ltd., one of the three British manufacturers who are parties to the agreement. The consignment, which left B.I.C.C.'s Prescot Works by rail in December for Hull and was shipped to Gdynia in the Polish motor vessel *Lech*, consists of 83 drums of 100 sq mm grooved copper trolley wire, 29 drums of 107 sq mm grooved cadmium copper trolley wire, and 15 drums of 19 strand hard drawn bare cadmium copper wire. A second consignment of 200 metric tons of 100 sq mm grooved copper trolley wire was later shipped from Hull aboard the Polish motor vessel *Baltic Jet*. The remainder of B.I.C.C.'s commitments under the contract, consisting entirely of this grade of wire, will be delivered at the rate of 100 tons per month over the next 18 months.

Industrial Inspection Equipment Exhibition

Production-Engineering, Ltd., is holding an exhibition of automatic industrial inspection equipment at its London headquarters, 12, Grosvenor Place, S.W.1, from 14th March to 31st July. The exhibition is being held in collaboration with Mullard Equipment, Ltd.; Teddington Industrial Controls, Ltd.; Baldwin Instrument Co., Ltd.; Industrial Products (Speco), Ltd.; Research & Control Instruments, Ltd.; Pye, Ltd.; Racal Engineering, Ltd.; and Venner, Ltd.

Marconi Mobile Showroom Continental Tour

The new mobile demonstration unit of Marconi Instruments, Ltd., has left St. Albans on a six-month tour of Continental factories, research establishments, government organisations, and technical colleges. The unit will visit Belgium, France, Italy, Austria, Switzerland, Germany and Holland in that order, covering more than six thousand miles.

Factories Act and the Factory Inspectorate

The Working Relations Sub-Committee of the Central London Productivity Association is arranging a meeting on 25th February at 21, Tothill Street, London, S.W.1 (2.30 p.m.), when Mr. A. W. Grimsey, H.M. District Inspector of Factories for the Central London District, will speak on "The Factories Act and the Work of the Factory Inspectorate." Application for tickets (2s 6d each for members and 5s for non-members) should be made to Mr. B. E. B. Turner, c/o Shell-Mex & B.P., Ltd., 1, Kingsway, London, W.C.2.

United States Electrical Trade

In Table 3 of the article published last week the item "Ditto parts and accessories 2,736" which follows "Electric propulsion motors for land vehicles" should have followed the previous item, "Motors above 200 h.p." Also in the same table, under "Primary switchboards, panels and parts above 750 V," "Argentina" should read "Brazil" and "Spain" "Argentina."

Lamp Publicity

The A.E.I. Lamp & Lighting Co., Ltd., is commencing a ten-week advertising campaign for Mazda "Netabulbs" at the end of this month. The campaign will be aimed primarily at housewives. Advertising magazine space has been booked on all I.T.V. stations and advertisements will also appear in selected provincial papers in areas not yet covered by I.T.V., and women's magazines. Over 40,000 retailers are being circularised with full details of the campaign, including lists of the showcards and literature available to them and invitations to take advantage of a free window dressing service. A booklet, "Netabulb in your home," containing hints on home lighting, will be advertised and is available to retailers as an additional point-of-sale aid for their counters.

A new Mazda "Netabulb" showcard

Mazda Netabulb
THE MODERN LAMP FOR THE MODERN HOME
Mazda
Mazda lamps stay brighter longer

Church Heating

The General Electric Co., Ltd., has issued a well-produced and illustrated booklet, "Keeping the Congregation Warm," in which the various forms of church heating are briefly dealt with.

Trade Announcements

The Glasgow and Manchester office addresses of **Bruce Peebles & Co., Ltd.,** have been changed. The Glasgow office is now at Carlton House, 26, Blythswood Square, Glasgow, C.2 (telephone: Central 6677; manager: Mr. H. V. Balm), and the Manchester office is at Peter House, St. Peter's Square, Manchester, 1 (telephone: Central 6690; manager: Mr. W. M. Clark).

The main sales engineering and contracts departments of **Lee Guinness, Ltd.,** have been moved from the company's headquarters and factories in Northern Ireland to 25, Victoria Street, London, S.W.1 (telephone: Abbey 6762). Mr. J. B. Souter is in charge of these departments under the direction of Mr. J. E. Bishop, general manager, who is responsible for the company's activities in London.

As from 1st January "Dagenite" aircraft batteries, which have previously been distributed by Peto & Radford, will be marketed by the manufacturers, **Pritchett & Gold and E.P.S. Co., Ltd.,** 137, Victoria Street, London, S.W.1, who are the proprietors of Peto & Radford.

Londex, Ltd., has signed an agreement making it the sole selling representative in Great Britain for a range of miniature relays manufactured at present in West Germany.

R. H. Cole (Overseas), Ltd., have been appointed the sole United Kingdom importers and distributors for the wide range of communications test gear made by Siemens & Halske. The range includes automatically synchronised equipment for the measurement of transmission levels for frequencies from a few cycles to approximately 10,000 Mc/s and a number of instruments for precision laboratory measurements of components.

Harlec, Ltd., South Molton, Devon, has appointed Wood's Agencies (Glasgow), Ltd., 375, St. Vincent Street, Glasgow, C.3, as its agents for Scotland and Northern Ireland.

Electric Elements (Willenhall), Ltd., has moved to its new factory at Spring Lane, Willenhall, Staffs. (telephone: Willenhall 870).

Photoelectronics (M.O.M.), Ltd., manufacturers of photocell, phototransistor and electronic controls, have appointed Paton Bros. Engineering Services, 15, St. James' Row, Sheffield, 1 (telephone: 29054), as their representatives in Yorkshire, and also, from 30, Northenden Road, Sale, Ches. (telephone: Pyramid 1959), as their agents in Lancashire and Cheshire.

Price Reductions

Ekco Heating (E. K. Cole, Ltd.) announces a reduction in the price of its "Minora" 2 kW low-level wall-mounting electric fire from £5 13s 8d to £4 8s 7d (including purchase tax).

Prices of Permali insulating transformer nuts have been reduced by an average of 16 per cent for the more popular sizes.

Change of Address

The London office of the British Welding Research Association is now at 19, Fitzroy Square, London, W.1 (telephone: Euston 9595/6).

Change of Name

Harlec (Tipton), Ltd., has changed its name to Harlec, Ltd.

Calendar

A neat desk calendar, showing three months on each card, has been received from Texas Instruments, Ltd.

PERSONAL AND SOCIAL

News of Men and Women of the Industry

At a board meeting held on 12th January **Mr. W. L. Fraser,** in accordance with an earlier intimation, formally requested his colleagues to accept his resignation from the board of Babcock & Wilcox, Ltd., to become effective after the annual general meeting on 26th May next. Mr. Fraser recalled that in July of this year he would have served a period of ten years as chairman, as was always envisaged. Moreover, the deputy chairman, **Sir Kenneth Hague,** would have fulfilled his term of office as president of the Engineering and Allied Employers' National Federation at the end of February. The board accepted Mr. Fraser's resignation and appointed Sir Kenneth Hague as chairman from 26th May. The directors also appointed **Sir Reginald Verdon Smith** as deputy chairman as from that date.

In order to retain Mr. Fraser's advice and experience, and in acknowledgment of his service, the directors decided to submit a resolution to the stockholders at the annual general meeting for the creation of the position of president of the company. If approved, they propose to invite Mr. Fraser to accept the appointment.

Mr. D. Edmundson

A.E.I. (Rugby), Ltd., announces the appointment of **Mr. D. Edmundson,** B.Sc., M.I.E.E., as general manager, Rugby Works. This will enable **Mr. H. E. Cox,** who has been general manager since 1957, to devote his time to the duties of deputy director of manufacture.

Mr. Edmundson was educated at Saffron Walden and Rugby College of Technology and Arts (now Rugby College of Engineering Technology) and served an engineering apprenticeship with the B.T.H. Co. In 1934 he became a design engineer in the A.C. Engineering Department, Rugby, and liaison engineer with the Motor Department, Trafford Park, Manchester. In 1940 he was appointed head of the electrical laboratory, and in 1946 test engineer, Rugby Works, eventually becoming superintendent, Test Department. He was then appointed assistant manager, manufacturing, being promoted manager, manufacturing, at the beginning of last year.

Mr. Edmundson was awarded the Silvanus Thompson Premium of the I.E.E. He is a past-chairman of the Midland Section of the Society of Instrument Technology, and past-secretary and chairman of the Rugby Sub-Centre of the I.E.E. At the present time he is chairman of the Engineering Advisory Committee, Rugby College of Engineering Technology.

Mr. R. H. Hensman, deputy secretary of Cable & Wireless, Ltd., has been appointed secretary of the company, with effect from 1st February, in succession to **Mr. F. H. Lansbury,** who, having passed the age of retirement, will relinquish the position at the end of this month after thirty-nine years' service. **Mr. H. A. Cox,** assistant secretary, has been appointed deputy secretary and **Mr. A. A. Willett** has been appointed assistant secretary.

Mr. N. G. Simpson, A.C.G.I., M.I.C.E., M.I.E.E., co-author of the article on "Overhead Lines v. Underground Cables" (page 167), received his training at the Royal Ordnance Factories, Woolwich. After holding technical positions with Sir Douglas Fox & Partners, Messrs. Kennedy & Donkin, and the Sevenoaks and Horley Electricity Companies, he joined Callender's Cable & Construction Co., Ltd., in 1938 as senior design engineer, becoming deputy manager of the Civil Engineering Department of the newly formed British Insulated Callender's Cables, Ltd., in 1946. He transferred to the British Insulated Callender's Construction Co. as commercial manager in 1949 and a year later was made assistant to the general manager, being appointed to his present position of transmission consultant in 1951.

Mr. P. W. Cave, joint author of the article, graduated from Bristol University in 1921, having obtained his practical training with the Metropolitan-Vickers Electrical Co. After a period in the Testing and Research Department of Pirelli-General Cable Works, Ltd., Southampton, he was appointed head of the Testing and Research Department of the Macintosh Cable Co. at Walton, Liverpool, later moving to the Derby works to become production and technical manager of the power cables side. In 1936 he joined the personal staff of the chief engineer of British Insulated Cables, Prescot, and since the merger of B.I. Cables with Callender's he has held the appointment of consultant engineer of the Power Cables Division and is now at the Erith Works of B.I.C.C. Mr. Cave has served on a number of British Standards Institution and Electrical Research Association committees and is a member of two of the International Electrotechnical Commission committees dealing with electrical installations in ships and high voltage power cables.

Mr. N. G. Simpson

Mr. P. W. Cave

Mr. E. Jackson, A.M.I.E.E., retired as London manager of Erskine, Heap & Co., Ltd., on 31st December after forty years' service in that position. He is still retaining his directorship of the company.

Mr. E. W. Batho, A.M.I.E.E., has succeeded him as London manager. Mr. Batho served his apprenticeship at the Willesden switchgear works of the B.T.H. Co., Ltd., receiving his technical training at the Polytechnic, Regent Street. He spent two years with the English Electric Co., Ltd., Stafford, in switchgear engineering, and one year with Johnson & Phillips, Ltd., in cable research, joining his present company in 1935. At the end of the war he was appointed deputy London manager.

Mr. E. W. Batho

The United Kingdom Atomic Energy Authority announces that **Mr. H. Cartwright,** M.B.E., M.A., A.I.Mech.E., A.M.I.E.E., at present serving as deputy director of industrial power in the Development and Engineering Group at Risley, has been appointed director of industrial power.

Mr. Cartwright was educated at William Hulme Grammar School, Manchester, and at St. John's College, Cambridge, where he took a first class honours degree in the mechanical sciences tripos in 1940. From 1942 to 1946 he was a signals officer on ground radar stations in the R.A.F., attaining the rank of flight lieutenant. After working for the Decca Navigator Co., Ltd., Brixton, and the English Electric Co., Ltd., Stafford, he joined the Atomic Energy Division of the Ministry of Supply at Risley in 1949 as a design engineer. In 1954, on the formation of the Atomic Energy Authority, Mr. Cartwright became an assistant chief engineer in the Authority's Industrial Group at Risley.

He was promoted to chief engineer in 1955, assistant director in 1956 and deputy director of industrial power in 1958.

Mr. H. Hardman has been appointed assistant secretary (purchasing, contracts and stores) in the Regional Secretary's Department of the Southern, South Western and South Wales Region of the Central Electricity Generating Board. Mr. Hardman was educated at Westoe Secondary School, South Shields, Co. Durham, and joined the electricity supply industry in 1933 as a member of the staff of the Central Electricity Board at Bristol. When the industry was nationalised in 1948, Mr. Hardman was appointed divisional purchasing officer for the South Western Division, which position he now relinquishes. He is a member of the Purchasing Officers' Association.

Mr. C. A. P. Cannon, who has been production manager of Measuring Instruments (Pullin), Ltd., since 1953, has now been appointed assistant to the managing director, Mr. J. P. Steward. In addition to his new duties, Mr. Cannon will continue to act as production manager of the M.I.P. works at Acton.

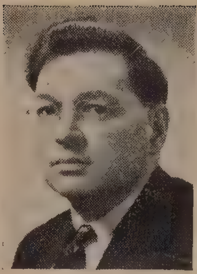
Mr. C. A. P. Cannon

Mr. W. H. Smith has decided to retire from the chairmanship and from the board of Allied Ironfounders, Ltd., on 31st March next. Mr. Smith has been over sixty years in the industry and was one of the original members of the board when the present holding company was formed in 1929. The new chairman will be **Mr. G. S. Steven,** vice-chairman and joint managing director, who will continue as joint managing director with **Mr. H. C. Wilson Bennetts.**

Mr. Steven started with the Allied group when he joined McDowall, Steven & Co., Ltd., Falkirk, in 1925. He was appointed deputy managing director of the group in 1954, became managing director in 1956, and vice-chairman and joint managing director in April last year.

At a recent meeting of the Council of the Gauge and Tool Makers' Association, **Mr. A. Dormer,** chairman and joint managing director of the Sheffield Twist Drill & Steel Co., Ltd., was appointed second vice-chairman of the Association to fill the vacancy caused by the death of Mr. H. G. C. Wilson.

Mr. D. D. Hogg, B.Sc., A.M.I.E.E., has been appointed contracts manager to the Bryce Electric Construction Co., Ltd., and is directly responsible to Mr. S. R. B. Brewer (sales director) for the Sales and Contracts Department of the company. He has been senior sales and contracts engineer for the past three years.


Mr. D. D. Hogg

Mr. J. O. M. Palmer

Mr. J. O. M. Palmer, A.M.I.E.E., has been appointed chief engineer to the company; he was appointed chief designer in November, 1958.

Mr. D. P. Taylor and **Mr. F. B. Chaventré** have joined the sales division of De Havilland Propellers, Ltd., to assist in the marketing of the company's industrial products.

Mr. Taylor was previously with the Solartron Electronic Group. In his new post he will assist with the sale of the industrial and laboratory electronic equipment produced by De Havilland Propellers, and will work closely with the System Engineering Group formed recently within the company. Mr. Chavantré was previously with Electroflo Meters, where he was a specialist representative covering system engineering. In his new capacity he will handle sales to the process control industry of the services and products offered by the Propeller Co.'s System Engineering Group.

Pye Process Heating announces the appointment of **Mr. R. P. Heatley,** A.M.Brit.I.R.E., as sales manager from 1st February. He commenced his career with the Marconi Co. and previous to his new appointment he was for many years a senior member of the Woden Transformer Co.

Mr. J. A. Crabtree, chairman of J. A. Crabtree & Co., Ltd., is a member of the Advisory Council on the Employment of Prisoners set up by the Home Secretary and the Secretary of State for Scotland.

Mr. W. L. Nicoll, A.M.I.E.E., has been appointed engineer-in-charge of the B.B.C.'s Kirk o' Shotts television and v.h.f. sound broadcasting station in succession to the late Mr. J. Cleland. Mr. Nicoll joined the Corporation in 1937 as a maintenance engineer at the Burghead transmitting station. He has held the post of assistant engineer-in-charge of the Kirk o' Shotts station since it was opened in March, 1952.

Mr. J. Sutton, Manchester manager for the Dictaphone Co., Ltd., since 1957, has been promoted northern divisional manager for the areas covered by the company's branches in Manchester, Leeds, Liverpool, Newcastle, Glasgow and Edinburgh. This is a new appointment and the new Dictaphone northern divisional office will be at Woolwich House, 59-61, Mosley Street, Manchester. **Mr. R. Wightman** has been appointed manager of the Manchester branch.

Mr. G. L. Knight has been appointed assistant to Captain R. A. Villiers, C.B.E., A.M.I.E.E., R.N. (Retd.), director of the Scientific Instrument Manufacturers' Association. He will operate under Captain Villiers in the field of information and external activities in particular, and will also be responsible for the collection and distribution of information for S.I.M.A.

Mr. A. J. Marles, B.Sc., A.C.G.I., A.M.I.Mech.E., has been appointed technical manager of the Ransome & Marles Bearing Co., Ltd. He was previously an assistant technical manager, and he takes up his new duties on 1st February.

Mr. G. Marchant has been appointed general manager of the Wolverhampton and Hednesford factories of the Fafnir Bearing Co., Ltd.

Mr. J. E. C. Bailey, C.B.E., M.I.Ex., chairman and managing director of Baird & Tatlock (London), Ltd., and Hopkin & Williams, Ltd., will leave by air on 30th January to visit the companies' branches, agents, representatives and customers throughout East, Central and South Africa.

Mr. F. H. Shrimpton has been appointed home centre manager of A.E.I. - Hotpoint, Ltd. He joined the B.T.H. Co. as an apprentice in 1927 and from 1934 was concerned with fractional h.p. motor sales and special contract work. From 1947 to 1949 he was district office manager, Hotpoint, Birmingham, and until 1953 was factory superintendent at the Premier Works, Birmingham, of which he became manager. In 1956 he was appointed southern division sales manager, and in December, 1957, he became marketing manager, small appliances.

Mr. F. H. Shrimpton

The **Birmingham Electric Club** is holding a dinner-dance on 4th March (7 for 7.25 p.m.) at the Grand Hotel, Birmingham. Applications for tickets (£2 5s each) should be made by 12th February to Mr. A. B. Frost, hon. social secretary, 38, Yewhurst Road, Solihull, Warwickshire.

J. F. Irvine & Co., Ltd., Dundee (now a subsidiary of Electrical Components (Holdings), Ltd.), recently celebrated the fortieth anniversary of its establishment by a dinner to the members of the staff at the Royal

Hotel, Dundee. The occasion was marked by the presentation of inscribed gold watches for long service to Mr. S. D. Goodfellow (38 years) and Mr. A. Martin (34 years) by the local director, Mr. A. Baillie.

The North Western Branch of the **Electrical Trades Commercial Travellers' Association** held a meeting on 11th January at the Sefton Hotel, Manchester. Mr. F. Foulkes, chairman, welcomed the members and following the meeting a talk was given by Mr. Roddis, of British European Airways, on "Air Travel and Organisation." Members are asked to make early application for tickets for the ladies' evening on 29th January, at the Lancashire County Cricket Club Pavilion, to any member of the committee or the social secretary, Mr. C. G. Walker, 12, Hartford Road, Sale, Ches.

The annual dinner of **F. Westerman (Wholesale), Ltd.,** a member of the Edmundson group of companies, was held at the Grand Hotel, Birmingham, recently when over fifty employees attended. Mr. H. E. Bagnall (director), in proposing the health of the staff, thanked them all for their loyal service during the past year, and Mrs. Bagnall presented clocks to three employees for long service. Among those present were Mr. and Mrs. F. Westerman and also Mr. Noel G. Smith and Mr. E. H. Maltby from Edmundsons, London. During the evening a presentation was made to Mr. Bagnall on behalf of the staff.

Commander P. W. Kent, R.N., chairman of **George Kent, Ltd.,** presided at the company's annual apprentice prize-giving and exhibition of work held at the Biscot Road Works, Luton, on 11th January. In addition to presenting prizes for individual successes both in work and studies, Commander Kent reviewed the many collective activities of the apprentices during 1959. Also present was the deputy chairman of the company, Mr. T. P. W. Norris.

Mr. A. V. Edwards, managing director of Ultra Electric (Holdings), Ltd., and subsidiaries, left London Airport on Saturday last for New York. He is visiting associates and agents of Ultra Electronics, Ltd., in the United States and Canada.

OBITUARY

Mr. S. C. Smith, head of the Purchase Department of Quasi-Arc, Ltd., died on 13th January. He had been with the company for nearly thirty-eight years.

WILLS

Mr. F. W. Leake, M.I.E.E., sales manager (works administration) with British Insulated Callender's Cables, Ltd., who died on 13th October last, left £33,195 gross (£31,216 net).

Mr. W. A. Turnbull, M.I.C.E., M.I.E.E., Wh.Sch., former borough electrical engineer of Aylesbury, who died on 26th September last, left £13,754 gross (£13,635 net). He left £50 to the Benevolent Fund of the Institution of Electrical Engineers.

Air Conditioning Plant for Paint Booths

In the new car body paint, trim and assembly building of the Ford Motor Co., Ltd., at Dagenham, there are 21 Sturtevant air conditioning plants handling a total air volume of 72 million cu ft per hour, installed to the order of John Lysaght's Bristol Works, Ltd. (Lysaght-De Vilbiss Division). The plants serve the various prime, final, enamel, two-tone and small parts spray booths and associated bake ovens with clean air at controlled temperature and humidity to provide the conditions necessary to achieve high quality finish. Each plant is controlled automatically by electronic detecting and controlling instruments, and all operating parts are interlocked electrically for sequence starting from a main control panel. An automatic isolating damper is fitted to each plant interlocked with the main air fans so that complete air shut-off can be achieved. The main air fans are of the Sturtevant high-efficiency, double inlet, double width type, with backward sloped impeller blades. Temperature control of the plants is achieved by heaters in various stages, commencing with a low temperature anti-freeze heater and terminating with a final after-heater.

For the high quality air filtration required in 12 plants, Sturtevant-manufactured "Precipitron" electrostatic filters are provided in addition to the fully automatic viscous filters fitted throughout. The electrostatic filters on these plants are rated for a total of 836,000 cu ft of air per minute or about 28 tons of atmospheric air, often containing in excess of 100 gm of dust, and will remove 95 per cent by weight of atmospheric smoke particles in the size range 0·01 to 1·0 micron diameter.

Hoover Fire Warning System

As a precaution against large-scale fire outbreak, Hoover, Ltd., have recently installed at their Perivale factory a new £20,000 fire detection system. The installation, which covers an area of approximately 215,000 sq ft, was designed and installed by Sound Diffusion (Auto-thermatic), Ltd.

Every part of the factory is covered and, in all, there are 2,000 automatic detectors distributed throughout twenty-eight sections. For ease of maintenance and alteration, coaxial type cables are used in the detector layout and the monitoring current (20 mA) is supplied by batteries. The majority of the detectors are set to operate at between 120°F and 130°F. In the event of a fire occurring, signals from the detectors are transmitted to the company's central fire control room.

Each section of the fire detection network is equipped with a telephone which utilises the same wiring system, so that a report can be sent back from the scene of a fire to central control. Apart from a loudspeaker system, alarm bells and detectors, all equipment associated with the system is housed in one compact cabinet. This cabinet contains a panel bearing the names of each section, with appropriate duplicated red lights to denote a fire outbreak. In addition, there are also facilities for the plug-in telephone and controls for routine testing of the equipment. Another function of the detection equipment is to send a pre-recorded message to the county fire brigade, if this is found to be necessary.

It is stated that plans are in hand to include the company's Wadsworth Road factory, half a mile away, in the new system.

The central console with duplicated fire warning lights, part of the "Auto-thermatic" fire detection system at Hoover's Perivale factory

Financial Section

STOCKS and SHARES

MERGER negotiations have produced the main points of interest in the electrical markets of the Stock Exchange over the past week or so, and a considerable impact upon the shares of some of the companies concerned with them. Reactions to first news of the contemplated amalgamation of A. Reyrolle and C. A. Parsons left no doubt about the market's view of the matter, the shares of both companies being marked up to much higher prices, although these were not fully maintained. Lancashire Dynamo £1 shares were raised very substantially by the announcement that the bid for the company's stocks from Metal Industries had been capped by a more valuable one from Electric & Musical Industries.

In general, the reactionary tendency in the course of industrial share prices continued to lower levels and the trend was still uncertain at the beginning of this week.

Reyrolle-Parsons

Immediately before the announcement of the merger proposals, A. Reyrolle £1 shares had receded further to 93s 3d and were subsequently raised to about 102s 6d. Those of C. A. Parsons were relatively little altered at 55s, after being 57s. According to the joint statement, the matter is still in the planning stage. Detailed proposals are not expected for two months or so, and are likely to include estimates of profits in the past year. The intention is to form a holding company to take over the share capitals of both companies, which have combined assets of some £55 million. In view of the fact that Reyrolle hold 40 per cent of the Parsons ordinary capital, the market conjectures that the former might form the basis of the proposed holding company.

Bids for Lancashire Dynamo

Lancashire Dynamo Holdings £1 shares stood at about 45s before the Christmas Eve announcement of the bid from Metal Industries. This had the effect of lifting the price of the shares to 65s, and it was hoisted further to the neighbourhood of 77s on news of the offer from Electric & Musical Industries on the basis of three E.M.I. 10s shares for every two in Lancashire Dynamo. With E.M.I. quoted at 53s 3d, this gave a value equivalent to nearly 80s for the L.D. shares, and put a price of over £11½ million (including an offer for the preference capital) on the whole undertaking. Metal Industries' earlier offer of four of their shares, plus 30s cash, for every five L.D. shares had made the latter worth about 64s 6d. Directors of L.D. have recommended shareholders to accept the E.M.I. offer. The Metal Industries board advised them to take no action pending a further announcement, and later they issued more detailed statements. The E.M.I.

Price Changes in

Company or Board	Nom. Value	Middle price 18th Jan.	Week's Rise or Fall	Dividend		Yield %			1959	
				Previous	Last	£	s	d	Highest	Lowest
Gilt-edged Stocks										
Brit. Elec. 1968/73	100	79		3	3	3	16	0	81	77¼
Brit. Elec. 1974/77	100	76		3	3	3	18	9	78	74¼
Brit. Elec. 1976/79	100	79		3½	3½	4	8	3	81	77½
Brit. Elec. 1974/79	100	90		4½	4½	4	14	6	91½	87½
Overseas Electric Supply										
Calcutta Elec.	£1	20/6		6·8†	7†	11	2	0	20/-	16/-
East African Power	£1	20/-		7½	8	8	0	0	22/6	19/3
Nigerian Elec.	£1	19/6		8	8	8	4	3	19/-	13/-
Perak Hydro-Elec.	£1	17/6		10	5	5	14	3	17/-	12/3
Electrical Shares										
Aberdare Holdings	5/-	17/6	−3d	17½	17½	5	0	0	18/9	15/6
Aerialite	1/-	9/-	−3d	54	54	6	0	0	12/3	7/9
Allen, W. H.	£1	58/9		11	12	4	1	9	58/9	43/-
Allied Insulators	5/-	23/-		—	20‡	4	7	0	23/6	18/9
Anglo-Portuguese Tel.	£1	28/-	+6d	9	9	6	8	6	30/9	26/6
Aron Elec. Ord.	£1	47/-		15	15	6	7	9	62/6	45/-
Assoc. Elec. Ord.	£1	65/9	+6d	15	15	4	11	3	67/-	53/9
Automatic Tel. & El.	5/-	21/9		17	17‡	3	18	0	21/9	18/-
Babcock & Wilcox	£1	45/6	−1/-	13¾	13	5	14	0	52/6	43/-
Bakelite	10/-	42/6	+1/3	15	15	3	10	6	41/3	22/-
Baldwin, H. J.	2/-	2/3		20	—	—			3/-	2/-
Berry's Electric	5/-	31/6		10	20‡*	3	3	6	33/6	7/3
Bowthorpe Holdings	2/-	11/-	−6d	25	27	2	19	0*	11/3	8/-
British Elec. Traction:										
Def. Ord. "A"	5/-	45/6	−1/6	25	35	3	17	0	49/6	35/6
B.I. Callender's	£1	59/3		12½	13½	4	11	3	60/6	44/9
B.I. Callender's 6% Pref.	£1	21/-		6	6	5	14	3	21/-	19/9
British Thermostat	5/-	25/-		30	35	3	10	0*	28/-	18/6
Brook Motors	10/-	58/-		25	25*	4	6	3	59/6	46/-
Bulgin, A. F.	1/-	13/6	−3d	45	50	3	14	0	13/9	6/9
Bulpitts	5/-	21/3		—	15	3	10	6	21/3	10/-
Burco Dean	5/-	15/6		16	18	5	16	3	19/6	12/3
Cable & Wireless:										
Ord.	5/-	19/9	−3d	10	10*	2	10	9	22/-	12/3
4% Loan	100	96		4	4	4	3	3	96	93
Chloride El. Storage "A"	£1	70/-	−1/-	17½	20‡	5	16	0*	73/-	43/8
Clarke Chapman	£1	62/6		27½	13¾*	4	8	0	66/3	52/6
Cole, E. K.	5/-	26/6	−3d	17½	20	3	15	6	27/6	17/3
Contactor Switchgear	5/-	16/3		14	14	4	6	3	16/9	12/-
Cossor, A. C.	5/-	9/9		Nil	5	2	11	3	9/6	6/3
Crabtree	10/-	52/6	−1/-	20	20	3	16	3	54/-	28/-
Crompton Parkinson	5/-	14/6		12	14	3	17	0*	15/-	9/6
Davis & Timmins	5/-	21/6		18	20	4	13	0	22/-	14/6
De La Rue	10/-	70/-	−3/6	17½	20	2	17	3	71/6	30/3
Decca "A"	10/-	47/-	−1/-	50	20*	4	5	0	50/6	33/3
Desoutter	5/-	38/9	+3d	25	21⅔*	2	16	0	37/6	19/-
Dewhurst	2/-	8/3		20	20	4	17	0	9/6	7/3
Dictograph Tel.	2/-	12/9		20	20	3	2	9	13/6	7/-
Dimplex	5/-	28/6	+3d	—	25‡	4	7	9	30/-	—
Dubilier Condenser	1/-	5/3		20	25	4	15	3	5/6	3/3
Duport	5/-	26/9	−3/-	12½	17½	3	5	6	28/6	10/3
E.M.I.	10/-	53/3	+9d	20	14*‡	2	12	9	56/6	31/6
Electrical Apparatus	5/-	13/9	−3d	14½	14½	5	5	0	16/6	13/-
Electrical Components	5/-	13/3	+3d	12½	15	3	15	6*	14/-	7/-
Elec. Construction	£1	37/-		8½	9	4	17	3	37/-	27/9
Elliott-Automation	5/-	27/6		—	11·2‡	2	0	9	30/6	16/9
Enfield Rolling Mills	£1	55/9	−6d	12½	15	5	7	6	60/-	36/9
English Electric	£1	47/9	−2/3	14	14	3	18	0	52/6	37/10
English Electric 3¾% Pref.	£1	13/-		3¾	3¾	5	13	3	13/6	12/3
Ericsson Tel.	5/-	26/3	−9d	12†	13†	4	1	0	28/-	22/3
Ever Ready	5/-	28/3	+3d	20	27½‡	2	18	6*	28/-	13/3
Falk Stadelmann	£1	35/-		10	10	5	14	3	35/6	25/-

The above quotations are based upon middle prices in the Stock Exchange Daily Official List.
* After scrip issue. † Free of income tax. ‡ Dividend indicated.

offers are open, conditionally, until 2nd February.

Price Changes

In the electrical sections of the industrial market, a rally in prices after a further recession left little net change in the general level. Alterations in the accompanying share list over the week were consequently fewer and of less significance than for some time past. Interest was attracted to English Electric by the big aircraft merger proposals affecting the company's aviation division, but the shares eased a further 2s 3d to 47s 9d. A.E.I. improved a little on balance to 65s 9d while G.E.C. shed 1s more to 44s 6d. Babcock & Wilcox at 45s 6d and Tube Investments at 129s 6d also lost ground. Clarke Chapman held their advance to 62s 6d and the rise of 3s to 57s 6d in R. A. Lister was outstanding. Venner 5s shares were quoted at 16s 9d after the declaration of a 7 per cent dividend for seven months, equivalent to an annual rate of 12 per cent, and effectively 2 per cent more than last year's payment. An increase in the Westinghouse Brake dividend from 10 to 11 per cent was apparently below expectations, for the shares were marked down initially by 4s, to 55s.

Increased Interims

Vactric 5s shares were not greatly affected, at 43s, by the declaration of an increase in the interim dividend to 15 per cent, on capital increased by a one-for-nine scrip issue since last year's corresponding payment of 12½ per cent. In the first half of the year ending next March, group profits of £224,000 (before tax) were a little below those earned in the same six months of 1958–59. Ultra Electric (Holdings) are also making a larger interim payment, of 7½ per cent. This compares with last year's rate of 5 per cent. At meetings on 8th February members will be asked to approve the proposals by which the present "A" (non-voting) shares would become one with the ordinary shares, holders of the latter receiving a 5 per cent scrip issue by way of compensation. For 1958–59 the company paid dividends totalling 20 per cent, on the basis of which the 5s shares at 27s yield 3¾ per cent.

Contactor Switchgear

Being concerned largely with the market for capital goods, Contactor Switchgear had to contend with severely competitive conditions in the financial year ended last July. Although output reached record proportions, profits at £79,000 (after tax) consequently came out rather below the high level of the previous year, but they still provided fully threefold cover for the maintenance of the dividend at 14 per cent, leaving £60,000 to be placed to reserves against the financing of a new factory. With arrears of orders in hand, and an improving tendency in the flow of new orders, the chairman expected, at the annual meeting, that the plant would be fully occupied this year and that results should be comparable with those of 1958–59. The 5s shares have been quoted lately at 16s 3d, offering a yield of just over 4¼ per cent.

James Scott

An interim dividend of 5 per cent declared by James Scott & Co. (Electrical Engineers) applies to

Electrical Investments

Company or Board	Nom. Value	Middle price 18th Jan.	Week's Rise or Fall	Dividend		Yield %			1959	
				Pre-vious	Last	£	s	d	High-est	Low-est
Electrical Shares—continued										
G.E.C.	£1	44/6	−1/-	10	10	4	10	0	48/-	31/3
G.E.C. 6½% Pref.	£1	22/-		6½	6½	5	18	3	23/-	20/3
General Cables	5/-	10/-	+1/-	24	15	7	10	0	9/3	7/6
Goblin (B.V.C.)	5/-	13/9		10	7½*	2	14	6	13/9	4/6
Greenwood & Batley	£1	117/6		20	20	3	8	0	117/6	75/-
Hackbridge Holdings	5/-	17/3		20	20	5	16	0	19/3	14/3
Hackbridge & Hewittic	5/-	14/9		20	20	5	1	9*	15/6	10/6
Head Wrightson	5/-	28/-		20	14‡*	2	10	0	31/6	16/6
Heatrae	2/-	9/6		20	20	4	4	3	10/-	7/6
Holophane	5/-	19/6		22½	26	6	13	3	20/-	14/9
Hoover	5/-	102/6	+2/6	50	60	2	18	6	103/9	55/-
I.C.I.	£1	59/9	−3d	12	8*	2	13	6	61/6	33/-
Intl. Combustion	5/-	46/-		25	30‡	3	5	3	43/6	29/9
Intl. Computers & T.	£1	76/3	+9d	—	10	2	12	6	78/9	57/6
Johnson & Phillips	£1	23/6	+1/-	5	5	4	5	0	30/6	18/3
Lancashire Dynamo	£1	77/-	+12/-	12½	10½‡*		—		65/-	31/6
Laurence Scott	5/-	19/6	+1/-	15	15	3	3	3*	18/9	14/-
Lister, R. A.	£1	57/6	+3/-	12½	14	4	17	3	55/6	32/9
Lucas, J.	£1	73/9		10	12½	3	7	9	78/6	43/3
Marconi Marine	£1	44/-	+6d	10	10	4	11	0	48/6	40/-
Marryat & Scott	2/-	14/6		37½	22½*	3	2	0	14/9	8/6
Mather & Platt	£1	51/3	−9d	15	10⅜*	4	3	6	52/-	41/3
Metal Industries	£1	73/-	−1/6	14	15‡	4	2	3	74/6	39/9
Midland Elec. Mfg.	£1	54/6	+2/-	12½	10*	3	13	6	52/6	41/6
Morphy-Richards	4/-	35/-		20	25	2	17	3	34/-	18/-
Murex	£1	73/9	−1/3	17½	15	4	1	3	76/-	42/-
Newman Ind.	2/-	5/-	+3d	10	10	4	0	0	3/6	2/3
Oldham & Son	1/-	2/9		17½	17½	6	7	3	3/3	2/6
Parsons, C. A.	£1	56/-	−9d	7½	8⅓‡	2	18	0	58/9	45/9
Philips' Lamps	Fl.10	157/6		14	14	1	13	6	160/-	88/-
Plessey	10/-	47/6		20	14*‡	2	19	0	48/6	23/6
Pye	5/-	18/-		12½	12½*‡	3	9	6	20/6	13/-
Pyrotenax	5/-	50/-		—	34	3	8	0	47/6	33/9
Radiation	£1	41/6	−1/-	5	6	2	17	9	43/9	24/9
Reliance Clifton	5/-	26/3		15	15	2	17	3	27/6	17/6
Reyrolle	£1	102/6	+6/6	17½	17½	3	8	3	98/-	85/9
Rheostatic	4/-	18/-	−6d	12½	20‡	4	9	0	18/6	8/3
Richardsons Westgarth	10/-	14/-		8⅓	8⅓	5	19	0	15/3	11/6
Simon-Carves	5/-	37/6	+1/3	25	25	3	6	9	37/6	28/6
Smith (England), S.	4/-	19/3		12½	17½	3	12	9	21/-	11/6
Southern Areas	£1	14/9		Nil	Nil		Nil		15/-	10/6
Strand Elec.	5/-	20/-		15	20	5	0	0	19/3	8/6
Sturtevant	5/-	23/9	+9d	15†	15†	5	3	0	23/6	17/-
Sun Elec.	5/-	15/6	−3d	25	15*	4	16	9	16/9	8/3
Switchgear & Cowans	5/-	16/6	+6d	22½	15*	4	11	0	16/6	10/3
T.C.C.	10/-	58/6	+1/-	25	25	4	5	6	58/6	38/-
Telephone Mfg.	5/-	7/3		10	10	6	18	0	7/3	4/9
Telephone Rentals	5/-	19/6		12½	12½*	3	4	0	22/6	11/9
Thompson (John)	5/-	23/9	−9d	25	25	5	5	3	25/6	19/6
Thorn Elec.	5/-	50/9	−1/3	17½	20	1	19	6	56/3	26/3
Thornycroft	£1	28/9	−6d	7½	6	4	3	6	31/6	20/6
Tube Investments...	£1	129/6	−6/-	17½	20	3	1	9	138/-	71/6
Vactric	5/-	43/-	+6d	25	37½	4	7	3	46/6	26/3
Walsall Conduits	4/-	15/6	−3d	22½	22½	3	6	0*	15/9	10/8
Ward & Goldstone	5/-	57/6		25	30	2	12	3	58/9	30/6
Watford	2/-	14/-	+2/-	25	25*	3	11	6	14/9	7/6
Westinghouse	£1	55/-	−4/-	10	11	4	0	0	59/-	39/6
West, Allen	5/-	14/3	−9d	12½	11⅔*	4	2	0	15/6	11/9
Wolf Electric	5/-	11/3	−6d	10	10	4	9	0	11/9	7/9

ordinary capital increased to £282,000 as a result of scrip issues distributed last September. At that time shareholders received one new ordinary share for every ten held, and also new $6\frac{1}{2}$ per cent preference shares in the ratio one-for-six. The interim distribution represents a fractional improvement on the rate paid for 1958, for which year the total was brought up to 24 per cent and was covered three times over by the distributable surplus of profits. The 5s shares were introduced to the Stock Exchange in 1955 at a price not much more than one-third of the recent quotation of 31s 6d. Increases in both earnings and dividends have been reported in each subsequent year. On the basis of a 24 per cent dividend, the yield on the shares is over $3\frac{3}{4}$ per cent.

REPORTS and DIVIDENDS

A. Reyrolle-C. A. Parsons Integration.—The boards of A. Reyrolle & Co., Ltd., and C. A. Parsons & Co., Ltd., propose to integrate the two businesses by setting up a holding company in which the share capital of the two companies will be vested. In a joint statement to stockholders, the boards of the two companies state that A. Reyrolle & Co., Ltd., own 40 per cent of the equity of C. A. Parsons & Co., Ltd. While this fact might at first sight appear to make a closer association between the two companies a comparatively easy matter it yet produces technical difficulties on the legal side. With a view to satisfying themselves of the feasibility of the implementation of the recommendations of both boards, the opinion of Counsel has been taken and Counsel has advised on a scheme. The two operating companies would trade as separate entities with their own managements and with their present works. The integration proposed will strengthen the existing commercial and technical collaboration, and take advantage of the diversity of the products of the two companies. It will also provide the advantages and economies of a unified organisation. The proposals are being worked out in detail and they will be communicated to the members of both companies as soon as possible.

Hawker Siddeley Group, Ltd.—The annual meeting was held on 14th January, Sir Thomas Sopwith (chairman) presiding. In his review of the year, Sir Thomas said that he believed they were now embarking on a phase of development for the group which could be one of the most rewarding in their history. After dealing with the aircraft side of the group's activities, and referring to the offers to the De Havilland and Blackburn companies, Sir Thomas dealt with some of the group's more important industrial activities.

Brush Electrical were successful in obtaining a contract from the British Transport Commission for the supply of sixty diesel-electric locomotives. Forty-four were delivered during the financial year and a repeat order for 100 locomotives for delivery in 1960 had been received. Further substantial orders from the C.E.G.B. and Area Boards had been received for transformers. The Switchgear and Rotating Machines Divisions continued to expand and the latter added to its range of marine equipment during the year by the acquisition of the Rotating Machine Division of Veritys. Manufacture of steam and industrial gas turbines and turbo-blowers were centralised at the new Hawker Siddeley Brush Turbine Co. at Gloucester. Their range of manufacture had been extended under licence arrangements with the Dresser Group of America.

Fuller Electric had a successful year and established another record in the size and rating of equipment produced, shipping the three largest transformers ever manufactured by this company. The company was developing new design and manufacturing techniques for higher voltages and had extended its range of tap-changer equipment. Mirrlees' order intake was high, an encouraging factor being the large proportion of repeat orders. An outstanding success had been the performance of its engines in the locomotives supplied by Brush Electrical to British Railways. After reviewing the activities of Mirrlees, National, Petters and Hawker Siddeley (Hamble), Sir Thomas said that High Duty Alloys had again had a successful year. The Jason reactor designed and built by the Hawker Siddeley Nuclear Power Co. was inaugurated by Sir John Cockcroft in November, when a contract for the sale of one reactor of this type to the Atomic Energy Authority was also announced. Sir Thomas also referred to the group's activities in Canada and Australia.

E.M.I. Bid for Lancashire Dynamo.—Electric & Musical Industries, Ltd., is making a counter-bid for the ordinary and preference capital of Lancashire Dynamo Holdings, Ltd. The terms are: For every £100 of Lancashire Dynamo preference stock, 42 ordinary shares of 10s in E.M.I., and for every £100 of Lancashire Dynamo ordinary stock, 150 ordinary shares in E.M.I. The board of Lancashire Dynamo has decided to recommend the acceptance of the E.M.I. offer. Sir Joseph Lockwood, chairman of E.M.I., states that he has been discussing the possibility of co-operation or amalgamation with the Lancashire Dynamo board for over a year. Preference stockholders in Lancashire Dynamo would receive the normal half-yearly dividend payable at the end of February. Ordinary holders would receive their final dividend of $7\frac{1}{2}$ per cent in respect of 1959; the new E.M.I. shares to be issued would not rank for the March interim dividend of 5 per cent, but would receive the 1959-60 final dividend of not less than 9 per cent. The board of E.M.I. considers that the development of practical applications for its electronic "know-how" must involve forming a connection with a company which has interests in the heavier side of the electrical industry. Lancashire Dynamo established an electronics subsidiary ten years ago and this subsidiary now accounts for 20 per cent of the group's turnover. Sir Joseph says that the linking of Lancashire Dynamo with E.M.I. would bring complementary interests together and might do something to overcome the shortage of first-class electronics engineers. It would add 20 per cent to E.M.I.'s turnover and push gramophone records down to some 40 per cent of the total.

It will be recalled that Metal Industries, Ltd., made an offer in December for the share capital of Lancashire Dynamo Holdings, Ltd.

The board of Metal Industries, Ltd., issued a statement to the effect that it was considering the terms of the bid by E.M.I. for the preference and ordinary stock of Lancashire Dynamo Holdings. The opinion was expressed that the amalgamation of the Lancashire Dynamo business with the electrical division of Metal Industries would bring considerable benefits to the shareholders of Metal Industries as well as to those of Lancashire Dynamo Holdings, Ltd., provided that the terms agreed did not over-capitalise the likely future earning capacity of the combined businesses.

The directors regretted that the interests of the company conflicted in this case with those of E.M.I. but they had made an approach to the board of Lancashire Dynamo Holdings more than eighteen months ago.

Radio Rentals, Ltd.—The main figures in the accounts for the year ended 31st August last, and the proposals for capitalising £1,400,000 of share premium account in a one-for-two scrip issue, were given in our issue of 25th December.

With the full report and accounts now issued, Mr. P. Perring-Thoms (chairman and joint managing director) reviews the year's activities, in the course of which he refers to the changes in Government controls and taxation for the television and radio industry, which he says involved material adjustments to the company's terms of trading.

Their policy of expansion has continued and a recent survey shows that their service covers over 80 per cent of the population of Great Britain and month by month this percentage is increasing. Through its subsidiary, Mains Radio Gramophones, Ltd., the group manufactures all its own sets, and in the year under review the output was increased to a new record level, and in the last three months, with the addition of only 10,000 sq ft of working space, the rate of output has again been increased by a further 25 per cent.

Since the end of the financial year trading has been on a satisfactory scale and installations up to Christmas considerably exceeded those carried out in the corresponding period of the previous year. With the entry of a number of companies in the rental field, they can expect increasing competition.

Elliott-Automation Acquisition.—Subject to certain consents required by the vendor, Elliott-Automation, Ltd., has bought for cash the nucleonic instrumentation business of Isotope Developments, Ltd. Elliott-Automation is acquiring the name and goodwill of the Isotope Development Co. but not the business of its subsidiary, R. A. Stephen & Co. The purpose of the merger is the wish of both companies to avoid the duplication of scientific effort in the nucleonic instrument industry. The merger will become effective on 5th February, subject to approval of members and stockholders of Isotope Developments which will change its name to Nucleonic Investments, and will continue to be the owner of R. A. Stephen & Co.

R. B. Pullin & Co., Ltd., report a group profit for the year to 30th September last of £316,990, as compared with £271,501 for 1957-58. Taxation absorbs £167,131, and it is proposed to pay a final dividend of 20 per cent on increased capital, making 25 per cent for the year (same, including a special interim dividend). General reserve receives £40,000.

Vactric, Ltd., reports a group profit, before taxation, for the half-year to 26th September last of approximately £224,000, as compared with £230,000 for the corresponding period of the preceding year. An interim dividend of 15 per cent is announced (against an equivalent of 11¼ per cent after allowing for a scrip issue).

Ultra Electric (Holdings), Ltd., is paying an interim dividend of 7½ per cent (against 5 per cent) on the ordinary and "A" ordinary stock. The conversion of the ordinary and "A" ordinary stocks into a single class of ordinary shares will be dealt with at an extraordinary meeting and separate meetings of the present stockholders to be held on 8th February. Subject to the resolutions being passed, the interim will be paid on the capital to be increased by a one-for-twenty scrip issue to present ordinary holders as compensation.

British Industrial Plastics, Ltd., reports group profits for the year to 30th September last of £1,113,026, as compared with £979,129 for the preceding year. After deducting £310,110 for depreciation and £357,300 for taxation, the net balance is £445,616 (against £312,508). General reserve receives £200,000. It is proposed to pay a final dividend of 15 per cent, making 22½ per cent for the year (against 20 per cent) on larger capital. The balance carried forward is £344,094 (against £273,345 brought in). It is proposed to capitalise £1,476,812 of reserves in a one-for-one scrip issue.

Sterling Electric Holdings, Ltd.—Land & General Developments, Ltd., has acquired for cash, at 4s per share, 1,182,148 ordinary shares of 1s each in Sterling Electric Holdings, Ltd., out of a total of 1,200,000 such shares in issue. The purchase consideration of £236,430 has been found from the company's banking facilities. Mr. D. A. Braithwaite and Sir Frank A. Newsam have resigned from the board of Sterling Electric Holdings and Mr. P. A. Bligh, Mr. D. C. McLeod and Mr. W. B. Lindley have been appointed directors. Mr. Bligh has been elected chairman of the company.

The Westinghouse Brake & Signal Co., Ltd., reports group trading profits for the year ended 3rd October last of £2,557,488, as compared with £2,035,101 for the preceding year. After providing £1,121,503 for taxation, the net balance is £1,286,795 (against £879,235). It is proposed to pay a dividend of 11 per cent for the year (against 10 per cent).

Venner, Ltd., is paying an ordinary dividend of 7 per cent for seven months to 31st July last on capital increased by a one-for-two scrip issue. For the previous twelve months a dividend of 15 per cent was paid on the old capital. Net profits for the seven months were £37,247, after taxation of £26,413.

The Cables Investment Trust, Ltd., is paying an interim dividend of 4⅙ per cent (unchanged).

The Calcutta Electric Supply Corporation, Ltd., has announced an interim dividend of 3½ per cent, tax free (unchanged).

James Scott (Electrical Engineers), Ltd., has declared an interim dividend of 5 per cent (unchanged) on increased capital.

New Companies

General Piped Television, Ltd.—Registered 6th January. Capital £100,000. Radio and television relay engineers, producers and originators of programmes, etc. So long as General Electric Co., Ltd., holds not less than one-fifth of the issued share capital it is empowered to appoint one director. Directors: J. F. Thomasson, J. R. Stopford, B. L. Arnold and M. M. Macqueen. Solicitors: L. C. Thomas & Son, Neath.

Nuclear Fuels, Ltd.—Registered 5th January. Capital £100. To acquire and hold shares and stocks; to carry on business as manufacturers of and dealers in and as agents for nuclear fuels and chemical products of all kinds, and as metallurgists, etc. Solicitors: Slaughter & May, 18, Austin Friars, E.C.2.

Kirkpatrick (Electrical), Ltd.—Registered 7th January. Capital £20,000. Distributors, merchants, manufacturers, importers and exporters of and dealers in domestic, industrial and commercial electrical supplies and equipment, radio, television and telephone apparatus, etc. Directors: G. H. Pratt and M. A. Roberts. Regd. office: 37, Murray Road, Workington, Cumberland.

Project Sales, Ltd.—Registered 6th January. Capital £3,000. Manufacturers of and dealers in electrical goods of all kinds, etc. Directors: Miss Cecilia E. Mort and Ralph Mort. Regd. office: 185/7, Infirmary Road, Sheffield, 6.

Lewis Huntingford, Ltd.—Registered 4th January. Capital £100. Electrical heating, ventilating and general engineers, etc. Solicitors: Warren & Warren, 31, Bedford Row, W.C.1.

Bankruptcies

C. A. Norwood, formerly an electrical contractor, lately residing and carrying on business at 38, Thornbury Road, London, S.W.2.—Order made 11th December suspending discharge for seven days; bankrupt discharged as from 18th December.

G. B. Bullen, 58, Canada Road, Cardiff, electrician.—Public examination 5th February at the County Court, County Court Buildings (First Floor), Westgate Street, Cardiff.

Contract Price Formulae

The British Electrical and Allied Manufacturers' Association has issued the figures for its contract price adjustment formulæ. In each case the rate of pay for adult male labour at 15th January is deemed to be 196s. The "costs of materials" figures are: For electrical machinery and equipment the Board of Trade index figures published on 15th January are 180·4 (1949=100) and 116·3 (1954=100); both figures are provisional. For turbo-generating and allied plant: Materials used in mechanical engineering industries 188·4 (1949=100) and 125·4 (1954=100); both figures are provisional. Blast furnaces and iron and steel melting and rolling (40 and 41) 189·0 (1949=100) and other steel goods, excluding tubes (311 and 312), 128·8 (1954=100); both figures are provisional. The price of ¾in o/d 18 s.w.g. brass condenser tubes (*Metal Bulletin*, 15th January) is 49¾d/lb.

Prices of Materials

In the accompanying table we give the basis prices of the more important materials used in the electrical industry. The figures given are the selling prices and are those quoted on Tuesday last.

ALUMINIUM ingots	ton £186 0s 0d
COPPER, H.C. Electro	ton £258 15s 0d
Fire Refined 99·70%	ton £257 0s 0d
Fire Refined 99·50%	ton £256 0s 0d
COPPER Tubes	lb 2s 6d
Sheet	ton £292 10s 0d
H.C. wire and strip	ton £310 5s 0d
LEAD, English	ton £74 10s 0d
Foreign	ton £73 0s 0d
MERCURY	flask £71 10s 0d
TIN, block (English)	ton £793 10s 0d
ZINC, G.O.B. Foreign	ton £95 10s 0d
BRASS Tubes (solid drawn)	lb 2s 0⅞d
Wire	lb 2s 10½d
PHOSPHORBRONZE Wire	lb 4s 3¾d
PLATINUM	oz £28 10s 0d
RUBBER, No. 1 R.S.S. spot	lb 36d—36½d

Extensible Oil Switch Units

TWO types of oil switch units for systems with fault capacities up to 250 MVA at 6·6 kV and 350 MVA at 11 kV have recently been announced by Johnson & Phillips, Ltd., Charlton, London, S.E.7. The switches, developed from the Type NX non-extensible ring main unit, are intended to line up with circuit-breaker units in composite switchboards for switching a ring main or spur feeder cable or to provide a safe means of isolating and earthing sections of cable and connected apparatus for maintenance purposes. Having the same width, 1ft 9½in, as the breaker units, a breaker can be easily substituted without seriously disturbing the switchboard layout should operating conditions change.

Type SX/A (air-insulated) and Type SX/F (compound-filled) units have been designed for a normal rating of 400 A and fully tested to B.S. 2631 for load breaking at 120 A and 520 A, i.e. 30 per cent at 130 per cent of full load, and for fault making on to the main and integral earth contacts. The switch has withstood a thermal test of 22 kA for three seconds, which is equivalent to the symmetrical breaking current associated with 250 MVA at 6·6 kV.

The switches are fitted with manually operated spring-driven mechanisms. A separate system of switch blades of the signal arm type for main and earth connections is provided, with both main and earth blades hinged on a common cable box terminal. The individual blades are operated by separate shafts and insulating links but one common spring is employed for the rotation of either shaft. Tubes within this spring interlock the external levers of the main and earth switches so that both main and earth blades can be opened together but not closed simultaneously. To open or close the switch the spring is charged by a removable handle placed over the top spigot and associated lever pin and turned through approximately 45°. The lever pin passes over centre and, driven by the spring, rotates the switch shaft driving plate, thus closing or opening the switch. The mechanism is designed to give an adequate operating force to the switch actuating shaft irrespective of the speed at which the operator charges the spring. The opening or closing of the earth blades is effected in a similar manner by applying the operating handle to the bottom spigot and associated lever pin. Glass fibre insulation is provided to protect the main blades from arc damage.

Cable testing plugs can be inserted through the top cover of the unit but access to the test orifices can only be made with the earth blades closed—which means that the main blades of the switch must be open. With the earth blades closed, cable test voltage leads can be safely connected to the test plugs, the earth blades being opened before the test voltage is applied. Opening of the earth blades automatically traps the test plugs and they cannot be withdrawn until the earth blades are returned to the closed position. The mechanical safety interlocks provided also ensure that it is impossible for the earth blades to be closed whilst the main blades are in the closed position—and vice versa—but both sets of switch blades can be in the "open" position. The test orifice cover cannot be opened unless the main switch blades are open and, when this cover is open, the main blades cannot be closed.

Means are provided for padlocking the test cover to prevent unauthorised opening and for locking the oil switches in their respective open or closed positions. Auxiliary switches can be provided on the rear of the unit to facilitate protection in certain system designs. A standard J. & P. cable box having three gland positions to facilitate cable entry from any direction is provided but special cable box arrangements can be supplied to suit customers' requirements. Epoxy resin or bakelised paper bushings can be fitted as required.

The removable lever being used to charge the spring to operate the main switch

TRADE MARK APPLICATIONS

APPLICATIONS have been made for the registration of the following trade marks. Objections may be entered up to 6th February:

Zetamatic. No. 790,693. Class 7. Combined washing and drying machines for domestic use.—Longford Electric Co., Ltd., 6, Grosvenor Street, Manchester, 1.

Denmore. No. 792,909. Class 7. Washing machines, drying machines, and combined washing and drying machines; mixing machines and electric machines for domestic purposes. **Denmore.** No. 792,910. Class 9. Electrical and scientific apparatus and instruments; radio, television, sound recording and sound reproducing instruments, and parts; electric vacuum cleaners.—Denham & Morley, Ltd., Heddonia House, 374, Euston Road, London, N.W.1.

Minifact. No. B782,408. Class 9. Voltage measuring and recording instruments incorporating potentiometers.—Société d'Exploitation de Produits Industriels (Sepi) S.A., Paris. Address for service, c/o Reddie & Grose, 6, Bream's Buildings, London, E.C.4.

Corruflex. No. 784,809. Class 9. Covered electric wire, electric cables and electric conduits.—Wandleside Cable Works, Ltd., 106, Garratt Lane, Wandsworth, London, S.W.18.

Pathfinder. No. 791,010. Class 9. Radio transmitting and radio receiving apparatus, none being for use for direction finding purposes.—R. A. Wilson, 1, Newry Avenue, Felixstowe, Suffolk.

Granadex. No. 794,979. Class 9. Electric induction communication apparatus, sound recording and sound reproducing apparatus, and parts.—Granada Theatres, Ltd., 36, Golden Square, London, W.1.

Datofonic. No. 795,610. Class 9. Electrical apparatus for use in communications and for checking (supervision).—Sound Diffusion (Sales), Ltd., Duracraft Works, Portslade, Sussex.

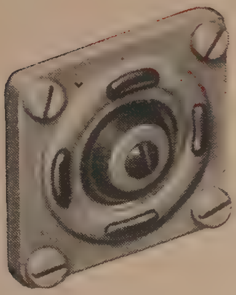
Boifix. No. 793,439. Class 11. Hot water storage tanks incorporating heating elements. — Allgemeine Elektricitäts - Gesellschaft, Berlin-Grunewald, Germany. Address for service, c/o Matthews, Haddan & Co., 31-32, Bedford Street, Strand, London, W.C.2.

Kompacto-lite. No. B795,286. Class 11. Electric lamps.—Siemens Edison Swan, Ltd., 33, Grosvenor Place, London, S.W.1.

New Tube Trains

The first of 76 new seven-car "silver" trains for London Transport Piccadilly Line was recently put into service. It has room for 15 per cent more passengers than the standard trains running on this line and, with its fluorescent lighting and rubber suspension, sets a new standard of comfort. It is the first of the production trains supplied by the Metropolitan-Cammell Carriage & Wagon Co., Ltd., against a £10 million order placed by London Transport in 1958—the largest single order for Underground rolling stock placed since the war. Further trains will now be brought into service at the rate of one a fortnight until mid-1962.

The traction motors for these trains are being supplied by the General Electric Co., Ltd., while the traction control and auxiliary equipment and motor generators are being supplied by Associated Electrical Industries, Ltd. The lighting and auxiliary equipment is being made by Benjamin Electric, Ltd., the auxiliary electrical equipment by the Patent Lighting Co., Ltd., and the batteries are being supplied by Peto & Radford, Ltd.



quietly doing a job

The photograph above shows a gramophone turntable bank in the Sound Control Room at the B.B.C. Television Studios, Lime Grove.

The arm and pick-up of the GLU9 groove locating units are mounted on pairs of SILENTBLOC Square Flange Instrument Type Anti-vibration Mountings, whose purpose is to make quite sure that no ground vibration interferes with the sensitive instruments and spoils absolute perfection of reproduction.

The B.B.C. are one of the many "perfectionist" customers who choose SILENTBLOC Instrument Mountings to do an exacting job.

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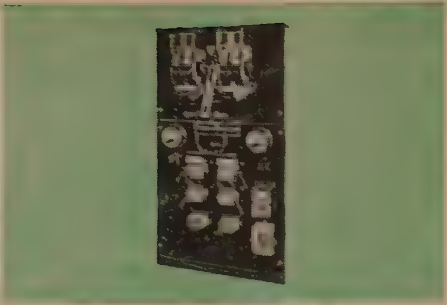
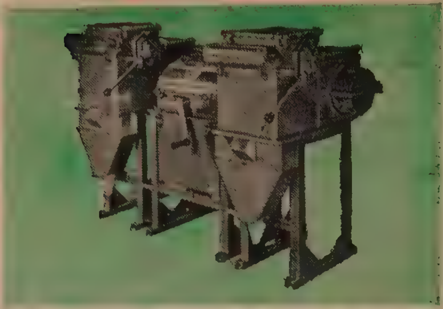
15 kV Oil Circuit Breaker for cubicle mounting

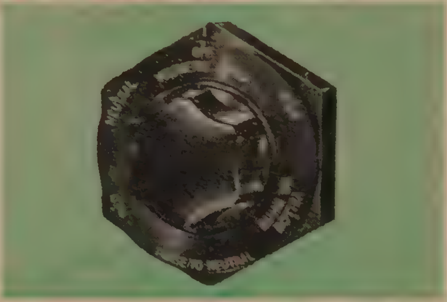


Heavy Current D.C. Circuit Breaker and Knife Switch Panel



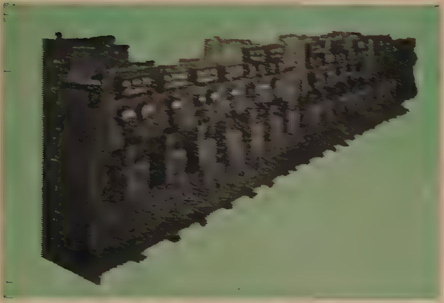
H.V. Ring Main Switchboard with Fuse Switch controlling Tee-Off

Small Air Circuit Breaker

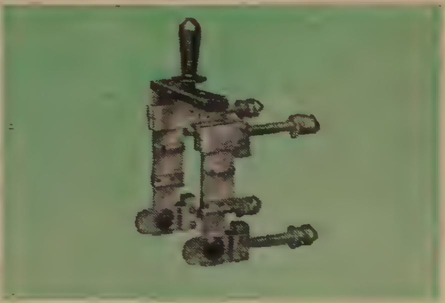


Ammeter and Voltmeter Switches

L.V. Industrial Oil Circuit Breaker

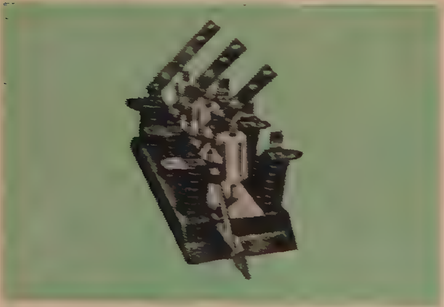


11 kV Metalclad Switchboard

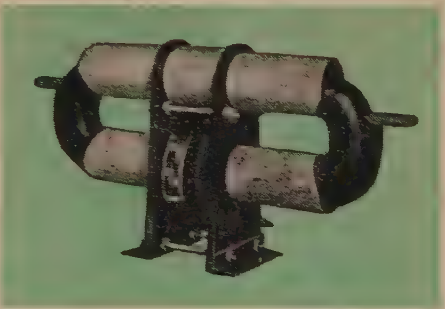


Panel Mounting Knife Switch

D.C. Switchboard for Steel Works



T.P. 11 kV Isolating Switch



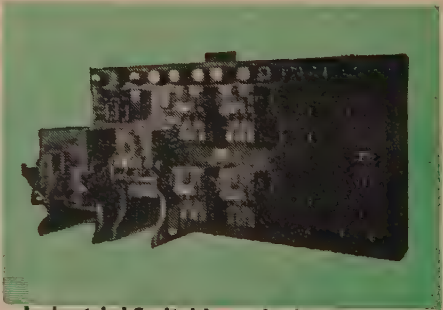
Current Transformers

Outdoor Pole Mounting Isolators

H.V. Switchboard incorporating Automatic Fuse Switch

STATTER

Specialists in Switchgear for over 50 Years



Industrial Switchboard with Drawout Oil Circuit Breakers

J. G. STATTER & CO. LTD

82 VICTORIA ST. LONDON SW1

Member of Lancashire Dynamo Group

The authors' object is to provide a balanced review of the two principal methods of transmitting electrical power. The discussion of the economics includes the cost of obtaining wayleaves and other preparatory work as well as capital and running costs. The different operational characteristics of the two systems are also shown to affect costs. The article concludes with a review of developments in design and operation and an indication of future trends

An Economic and Operational Comparison

Overhead Lines versus Underground Cables

By N. G. SIMPSON, A.C.G.I., M.I.C.E., M.I.E.E. and P. W. CAVE, B.Sc., M.I.E.E., Mem.A.I.E.E.*

IN the early days of electricity supply, before the turn of the century, distribution was largely restricted to the vicinity of generating plant in urban areas and was nearly all underground. With the well-established overhead telegraph in mind, supply engineers were no doubt attracted by the simplicity and easy maintenance of overhead power distribution, but the potential dangers of exposed conductors in built-up areas and the absence of any statutory control delayed its initial development. When the three-phase a.c. system became the accepted method of supply, there followed a progressive development of higher system voltages and the means for transmission and distribution beyond the urban boundaries. The character of rural supplies was naturally different from that in towns and the economics such that only the cheapest method of conveyance was possible, this being the overhead system using cross-country routes for transmission and roadside verges for distribution.

The adoption of overhead construction in rural areas thus became inevitable and statutory regulations were formed to impose the necessary structural and operational safeguards. The extent of this development over the last 50 years is shown by the route miles installed during the period. In 1907 there were 50 miles of overhead construction. In 1914 there were approximately 1,000 miles and at the present time there are over 60,000 miles installed. In general, underground cables have been retained for use in the majority of towns and urban areas in this country and overhead lines have been and are still being used extensively for the provision and reinforcement of supplies in rural areas.

TABLE I.—SUPPLIED AND INSTALLED COSTS OF REPRESENTATIVE OVERHEAD LINES AND UNDERGROUND CABLES

	Overhead Lines	Underground Cables
(1) 400/230 V	4 Wire 0·1 sq in Copper Wood Poles	4 core 0·15 sq in Copper (1,100 V) p.i.l.s.w.a. & s. Cable
Current rating	300 A	290 A
kVA-yd for 6% volts drop	27,700	55,200
Cost/mile	£2,600	£7,400
(2) 11 kV	3 Wire 0·05 sq in s.c.a. Wood Poles	3 core 0·06 sq in Copper p.i.l.s.w.a. & s. Cable
Current rating	200 A	145 A
kVA-mile for 10% volts drop	11,000	15,200
Cost/mile	£950	£6,900
(3) 33 kV	3 Wire 0·1 sq in s.c.a. Wood Poles	3 core 0·1 sq in Copper p.i.l.s.w.a. & s. Cable
Current rating	306 A	205 A
kVA-mile for 10% volts drop	141,500	206,000
Cost/mile	£1,900	£11,200
(4) 132 kV	Double Circuit 0·175 sq in s.c.a. Steel Towers	2–3 core 0·3 sq in Copper Oil-filled Cable
Current rating	470 A	370 A
Circuit rating	85 MVA/circuit	85 MVA/cable
Cost/mile	£9,000	£44,200
(5) 275 kV	Double Circuit 2 × 0·4 sq in s.c.a. Steel Towers	4–3 single core 0·75 sq in Copper Oil filled Cable
Current rating	1,500 A	525 A per trefoil group
Circuit rating	500 MVA/circuit	500 MVA per two trefoil groups
Cost/mile	£22,500	£230,700 (4 trefoil groups)

An important change in the pattern and economics of electricity supply occurred when the British grid came into operation after 1930. Generation from that time became concentrated more at selected sites with reliance on a country-wide network of e.h.v. overhead lines for the transmission of electricity to local bulk supply points. Large and prominent lattice steel structures have been responsible for both the great awareness of electricity supply development in the public mind and for the objections which have always existed against overhead systems.

Costs

Table I gives estimated present-day combined material and installation costs of a representative range of three-phase overhead lines and underground cables in the United Kingdom. The cable and overhead line conductor sizes in the l.v. case have the same current rating while those in the 11 and 33 kV range are based on a common voltage drop and representative overhead line distances. For the 132 and 275 kV comparison, cable sizes are based on the accepted transmission line load ratings. Rural conditions have been assumed throughout for cable excavation and reinstatement.

Installation costs for overhead lines are approximately 30 per cent of material costs but with underground cables the proportion varies from approximately 200 per cent of the cable cost in the low voltage case to 25 per cent at 275 kV.

In all cases, overhead lines are shown to be cheaper than underground cables with a steep increase in the difference in the e.h.v. range. There are, however, a number of additional and indirect cost factors which should be evaluated and taken into account in specific cases, especially

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* Mr. Simpson is with British Insulated Callender's Construction Co., Ltd., and Mr. Cave is with British Insulated Callender's Cables, Ltd.

An extreme example of city overhead distribution in Toronto

275 kV supergrid lines in the United Kingdom

if, for reasons of amenities, underground cable is strongly favoured.

Prior to the construction of cross-country h.v. overhead lines, extensive preparatory work is necessary. Apart from the reconnaissance surveys associated with route selection, lengthy and expensive statutory formalities must be observed in all cases to obtain the consents of the Ministry of Power and other public authorities and those of private owners and occupiers of land over which the line is planned. A considerable amount of supply authority staff work is involved firstly in obtaining details of land ownership and tenancies, prior to the serving of statutory notices to be followed by negotiations with County and District Councils, Post Office, Railway and Air Ministry departments as well as landowners, tenants and estate agents and solicitors who may act on their behalf. Inevitably there are objections which create delays, some of which are prolonged in an endeavour to reach agreement without resorting to arbitration. Route diversions are sometimes necessary involving further statutory procedure. This preliminary work may take many months to complete before a final working survey can be undertaken to establish a profile plan upon which support positions can be plotted with accuracy and material schedules prepared. The cost of this preparatory work is always appreciable. Moreover, there may be a substantial loss of revenue arising from a long delay in commissioning, especially with e.h.v. high load capacity transmission lines.

Annual wayleave acknowledgment and compensatory rentals for overhead line supports and stays should be included in the overall line cost and capitalised for this purpose. The comparatively large base area of lattice steel towers, for example, may prevent or hinder cultivation over 40 or 50 sq yd of ground and the compensation rents can be high. In some overseas countries, wide continuous tracts may have to be purchased outright. In North America, it is becoming increasingly difficult to acquire suitable rights of way, largely because of the general increase in land utilisation and values. The extensive use of aircraft also has a marked effect on both route selection and construction form, i.e. the adoption of single or double circuit lines. Existing rights of way are by contrast rendered more valuable and there are many current schemes for raising the voltage or increasing the number of circuits on existing lines to avoid the expense and complications of establishing new rights of way.

These difficulties will increase in the future and there is no doubt that underground cables will be used to a greater extent especially around towns. Rights of way or wayleave difficulties have for example been a contributing factor in the decision to place the Vancouver City 230 kV ring main underground.

The cost of overhead line preparatory work is substantially the same whatever the system voltage, so that when it is added to the smaller material and construction costs of, say, 11 and 33 kV lines the effect is proportionately greater than for lines of higher voltage. Even when all first costs are correctly estimated, consideration should be given to the life, maintenance and operational cost differences between overhead and underground systems and the whole may be taken into account by converting all costs to an annual charge.

Capital Charges

The life of overhead lines and underground cables is now assumed to be 30 and 40 years respectively, so that the interest and sinking fund payments which make up the annual capital charges are, as a percentage, less for underground cables than for overhead lines. The remaining portion of an annual charge is made up of management, routine maintenance and repairs to which must be added ultimately the cost of transmission losses. Management charges do not vary with the type of installation and can be covered by a common percentage addition, but in allocating charges for maintenance and repairs some discrimination should be applied between overhead and underground portions of a system since the operational conditions are so different.

Overhead lines operate under continuous mechanical stress and exposure to varying climatic conditions, resulting in progressive deterioration from both mechanical wear and corrosion. Routine line patrols are an essential part of overhead line maintenance procedure and appreciable staff and transport charges are incurred. Apart from occasional breakdown repairs, there are a number of line components which are subject to periodic replacement because their reliable working life is comparatively short.

The magnitude and cost of overhead line maintenance varies with the position and form of construction adopted. Deterioration is much more severe in industrial areas. While, for example, the galvanised coatings of lattice steel structures remain unimpaired for over 30 years in rural areas, those subject to intensive industrial contamination have often become defective within 10 years and consequently complete towers are painted to prevent serious steel corrosion. For some years, a systematic painting programme of 132 kV grid line towers in industrial regions has been in progress involving many hundreds of towers every year. Lower voltage line supports are mostly creosoted wood poles and a large proportion in this country can be relied upon to last for over 30 years. This situation, however, depends upon the strict application of high standards of supervision on timber quality, felling times and impregnation treatment. Relaxations in any of these can seriously reduce the life of a large batch of poles, involving early and costly replacements.

Underground cable installations are largely unencumbered with rights of way difficulties. They are also free from the progressive mechanical and corrosive deterioration of overhead lines. Effective anti-corrosive coverings are applied at the outset and are incidentally a part of the first cost. Service maintenance is normally unnecessary except that with important feeders, especially oil or gas filled types, routine voltage checks on such coverings may become general practice.

Operation

The annual costs of routine maintenance can be estimated without difficulty for either underground or overhead parts of a system and must in all cases be less for underground cables. The costs of full maintenance are less predictable since they include repair work arising from operational faults, the extent, frequency and costs of which may vary so much. This distinction between fault repairs and service maintenance is important because the former provides an index of reliability, a factor which again favours underground cable.

Although overhead lines are designed to withstand the majority of wind and ice storms, occasionally a storm of exceptional severity occurs which causes widespread damage, shutdowns over wide areas and extensive repair work—usually at times of heavy winter demand. Summer storms cause frequent shutdowns from lightning on lines of all but the highest voltage. Such overhead faults are admittedly occasional and superimposed on conditions which normally provide a high degree of operational reliability. Nevertheless, such effects would not be tolerated in a densely built-up area where cables are normally used. The natural protection given to underground cables together with the improvements in dielectrics, sheathing, general protection and jointing has now established a high degree of reliability. Failures due to mechanical damage still remain, however, despite elaborate cover tiles and armouring. The time involved in locating and repairing faults is greater than with overhead lines although the effects can mostly be localised through the medium of alternative supplies.

Supply reliability is an important issue when comparing the two forms of transmission and distribution. Although a measure of it may be applied in the form of maintenance and repair costs, supply interruptions involve also loss of revenue and goodwill.

An objective comparison of the two systems is not complete until consideration is given to the difference in efficiency with which they transmit or distribute electricity. These differences arise principally from the fact that the greater spacing of bare overhead line conductors results in high inductance circuits and high current ratings, while insulated underground cables have comparatively high capacitance and lower current ratings. The effect of high inductance on overhead line voltage is appreciable. Shunt capacitors or synchronous condensers may be required to improve the power factor and reduce the inductive reactance drop. The high capacitance of cables on the other hand draws a correspondingly large capacitance (leading) current, the kVA of which is roughly proportional to the system voltage and route length.

These differences in electrical characteristics can influence the choice between overhead and underground systems. With networks up to 33 kV, the overall power factor improvement with cables may result in marked financial advantages which can be offset against the greater first costs. The use of e.h.v. cables for long-distance transmission, however, is limited by the difficulties in supplying the required leading kVA. The maximum lengths for three-phase feeder cables from 66 kV to 380 kV, range from approximately 60 miles down to 10-15 miles

11 kV secondary transmission in the United Kingdom

A British low voltage overhead village distribution system

TABLE II.—ELECTRICAL CHARACTERISTICS OF REPRESENTATIVE THREE-PHASE OVERHEAD AND UNDERGROUND CIRCUITS

		Overhead Lines	Underground Cables	
			Solid Type	Oil-Filled
(1) 400/230 V–0·1 sq in				
Resistance/1,000 yd	ohms	0·252	0·252	
Reactance ,,	,,	0·254	0·067	
Thermal rating	amps	308	208	
	kVA	215	144	
Corresponding feeder lengths to produce 6% volts drop (Feeder supplied one end only)	yd	120	275	
(2) 33 kV–0·15 sq in				
Resistance/1,000 yd	ohms	0·169	0·172	0·172
Reactance ,,	,,	0·334	0·104	0·084
Capacitance ,,	μF	0·0093	0·24	0·45
Charging current/1,000 yd	amps	0·056	1·44	2·70
Charging kVA ,,	kVAr	3·2	82·0	154·0
Example—30,000 yd length–8 MW 0·8 p.f. lagging at receiving end				
Volts drop	%	9·6	5·4	4·8
Sending end load	MVA	9·95	8·75	8·1
Sending end p.f.		0·81	0·91	0·99
Charging kVA (No load)	kVAr	96	2,470	4,630
(3) 132 kV–0·20 sq in				
Resistance/1,000 yd	ohms	0·125	—	0·129
Reactance ,,	,,	0·39	—	0·114
Capacitance ,,	μF	0·0079	—	0·210
Charging current/1,000 yd	amps	0·20	—	5·0
Charging kVA ,,	kVAr	43·5	—	1,140
Example—30,000 yd length–60 MW 0·9 p.f. lagging at receiving end				
Volts drop	%	3·3	—	1·8
Sending end load	MVA	65·8	—	60·0
Sending end p.f.		0·91	—	1·0
Charging kVA (no load)	kVAr	1,300	—	34,200

on this account. Lagging kVAr may be injected by shunt reactors or synchronous condensers with correspondingly greater expense, control problems and losses.

A measure of the differences between overhead and underground circuit characteristics can best be shown by three typical examples (see Table II). The low voltage comparison shows that the insulated cable is capable of being used for more kVA-yd than the overhead line although its current rating is lower. At 33 kV, the cable charging kVA exercises a beneficial effect in improving the regulation and reducing the overall kVA demand, at least at full load conditions. At 132 kV, it is clear that the cable charging current sets a definite limit to the length of cable that can be employed unless heavy compensation is superimposed.

There remains, finally, the issue of electrical losses, the cost of which should be determined in making up the annual charges for either overhead or underground systems. With the former, I^2R losses only need be considered. Insulator leakage and corona losses are controlled by design to small proportions. Also, for the majority of installed cables, the only losses of importance are due to I^2R and there is incidentally often an advantage in using cables of higher rating than necessary when the annual capital charges and losses are compared.

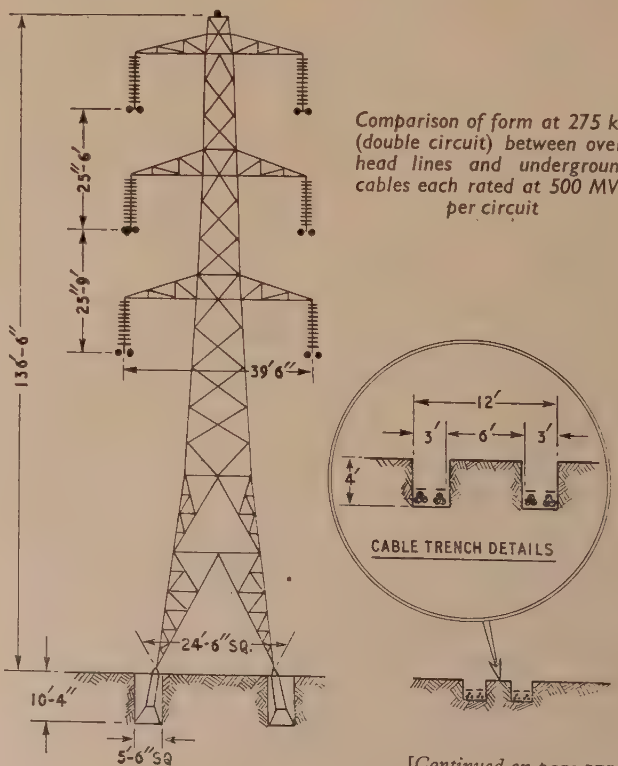
Above 33 kV, dielectric losses are no longer negligible and increase rapidly with voltage. At the highest voltages they substantially reduce current rating and add considerably to the overall cost of losses.

Developments and Trends

The present high cost of both forms of transmission give no indication of the progressive engineering economies that have been achieved. Overhead line designs were originally conservative with elaborate safety devices. Relaxations and standardisation, especially in the sphere of distribution, have been applied without reducing operational efficiency. The factors which have been most effective in establishing a stable and inexpensive technique are the reliability and adaptability of the wood pole, and the electrical and mechanical efficiency of porcelain and glass insulators, throughout the whole range of existing system voltages. Finally, there is the extent to which the dual conductor requirements of conductivity and strength have been satisfactorily met using copper or aluminium as basic components.

There are not likely to be any substantial material economies in the future. On the contrary, there will be trends towards operational improvements, especially in protection against lightning. There may be a greater use of plastics for the improvement and reinforcement of primary insulation.

Generally, this less expensive form of conveying electric power has remained a normal first choice over a period of 50 years in all but city and urban areas because overhead lines are comparatively cheap and operate to an acceptable standard. The method is cheap because it is based largely on straightforward structural principles involving materials and components of comparatively low fabrication content. Progressive increases in system voltage and power have not hitherto been delayed by the need to solve vital research problems. Future increases will warrant some further experimental work into insulation, corona and radio interference phenomena, but the scope and cost will be comparatively small. On the other hand, in the parallel field of power cable development these higher voltage requirements have been fully met, but only by overcoming a sequence of complex technical problems involving continuous and costly research programmes. For example, techniques have been established for preventing the formation of voids or otherwise eliminating ionisation in cable dielectrics, the occurrence of which has in the past been responsible for the adoption of low electrical working stresses and temperatures. Design levels for stress and temperature have steadily increased, associated with closer control in materials and production methods, and have resulted in substantial economies and greater overall reliability. To a lesser degree, improvements have also been extended to lower voltage cables. The high price of copper and lead during the last 20 years has stimulated the use of aluminium for the conductors and sheaths of power cables. Resulting savings have, however,



Comparison of form at 275 kV (double circuit) between overhead lines and underground cables each rated at 500 MVA per circuit

[Continued on page 171

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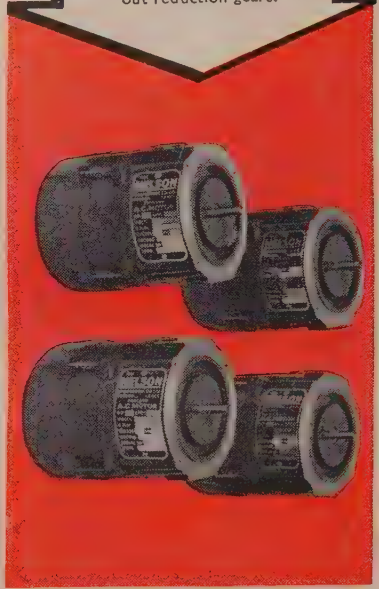

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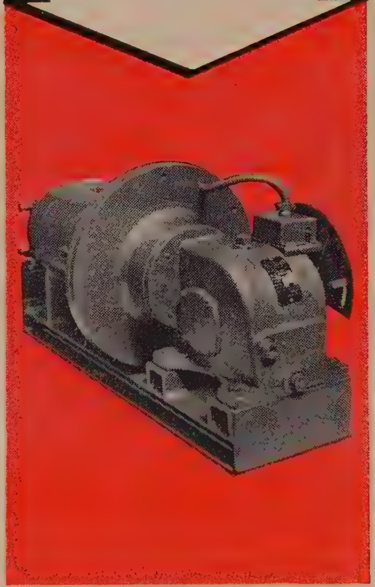

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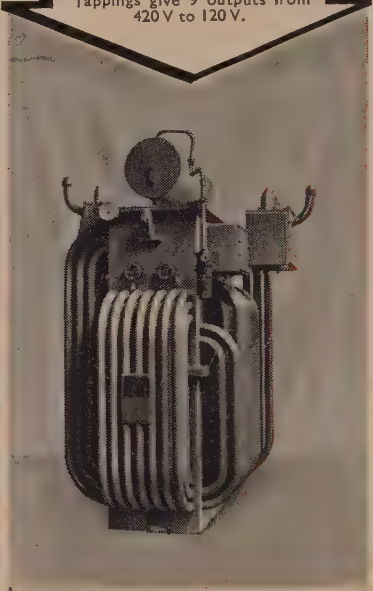

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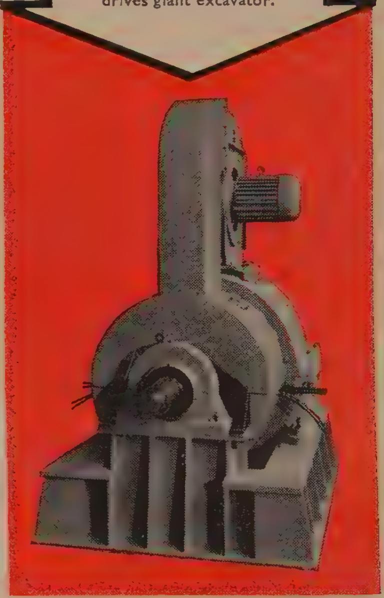

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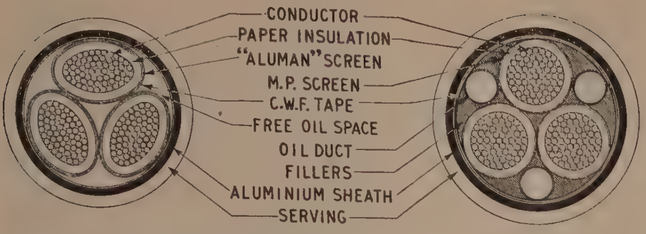


A trend in e.h.v. cable development (B.I.C.C.). Left, a cross-section of ductless shaped conductor oil-filled cable. Right, a cross-section of a conventional circular conductor oil-filled cable

been offset to a large extent by the larger insulation costs over the greater aluminium conductor diameters. Overall there are advantages in weight reduction, superior sheath strength, fatigue resistance and elimination of armouring. Against this, additional precautions are required against corrosion.

Impregnated paper cables with metal sheaths and armouring have been used for almost all transmission and distribution mains during the last 50 years. There is now a definite trend towards a greater use of plastic insulated cables which require no metallic sheaths. Provisional standards have been established for voltages up to 3·3 kV and active development continues up to 11 kV and above. There are, naturally, outstanding technical and operational problems to be resolved, but these cables have shown themselves competitive with conventional paper cables, principally due to savings in joints and terminations. They are particularly suitable for suspension above ground where excavation and reinstatement costs are avoided. This compromise in both cost and form between bare overhead lines and underground cables is used extensively in North America. There is greater security of supply and faults are repaired in shorter times.

Current rating remains a critical engineering factor in the economics of power cables and investigations continue with the object of establishing the maximum possible load which can safely be carried without affecting the life of the cable and the thermal properties of the surrounding soil. The condition of the cable and soil must be considered jointly since there is a limiting soil temperature above which moisture moves away from the cable. This creates thermal instability, since the soil thermal resistivity increases within the vicinity of the cable so that the cable temperature also rises. The behaviour of soils is subject to very wide variation and cases have arisen where soil with good thermal characteristics has been imported to replace a section of route with inferior soils to increase the current rating.

Installation Equipment

Installation practice for both overhead lines and underground cables has improved progressively with the increase in scope and power of mechanical plant, although these advantages are lost to a large extent in Britain by delays, access difficulties and lack of manœuvrability in the case of overhead lines and obstructions and lack of continuity as regards excavation and reinstatement with underground cables. Mechanical earth augers have, however, been used extensively for the foundations of wood poles with appreciable cost reductions. Most forms of mechanical plant are expensive both in first cost, maintenance and depreciation so that a high load factor is essential in most cases for such methods to be cheaper overall than the alternative use of manual labour. Mechanical pulling-in of cables has certainly become a routine feature of cable laying and has reached a high peak of efficiency.

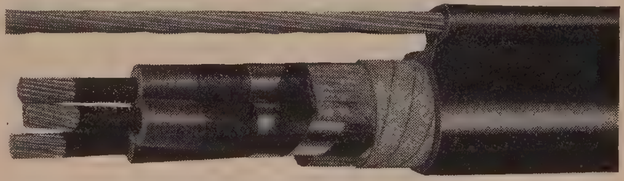
Jointing costs, especially with the higher voltage cables, form a large proportion of the total installation cost and are not easy to avoid because of the technique and precision involved. There is, nevertheless, much scope for economy, particularly with low voltage plastic cables. A reduction in the number of joints is prevented, in most cases, by the limited trenching that can be exposed at one time. If, however, underground cables were to be utilised to a greater extent in rural areas with a corresponding increase in continuity, then the scope for mechanisation would be increased and much greater drum lengths of cable could be employed at one time.

Conclusions

Overhead lines are less expensive than underground cables throughout the whole range of system voltages, differences being extreme at the higher voltages.

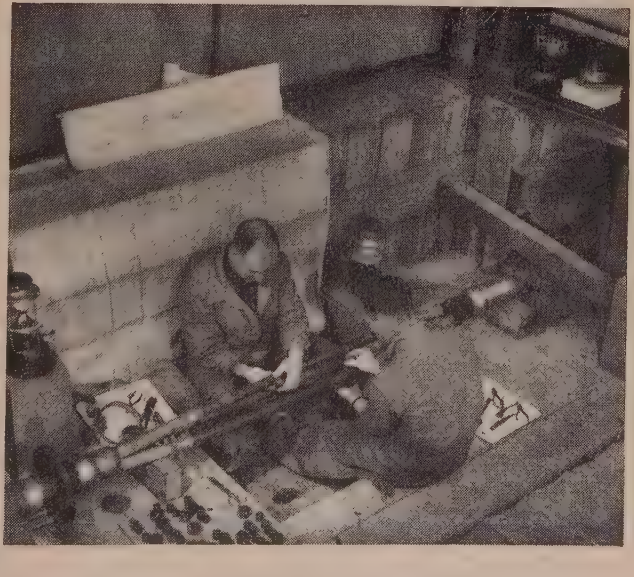
In the lower voltage range, the first cost differences are still appreciable but when all constructional and operational costs are evaluated, preferably on a basis of annual charges, the difference in cost between the two systems is not so great.

In city and urban districts, underground cables are the only practicable medium for all supply purposes. In suburban and rural districts subject to progressive development, cables will be used to an increasing extent because of their greater utilisation value and reliability, the trend towards reduced costs (e.g. through the medium of plastic cables) and the elimination of unsightly above ground mains and services. In open and extensive undeveloped rural areas, overhead lines must continue to be used especially for extra high voltage transmission. The trends in development will, however, be towards improvement in supply reliability and an extended use of overhead self-supported cables.



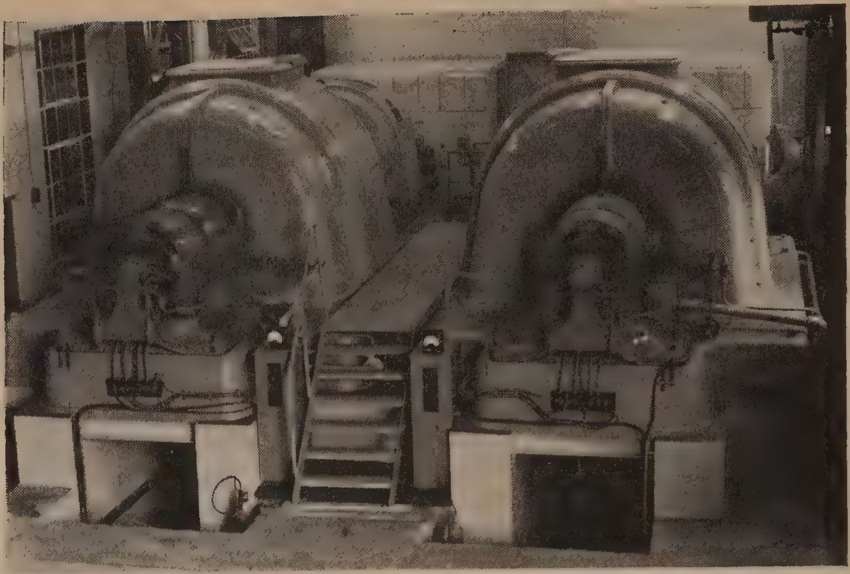
A self-supporting 11 kV three-core aerial power cable with polythene insulation and p.v.c. sheath (B.I.C.C.)

Precision and care is required in jointing e.h.v. cables. The illustration shows a 132 kV three-core straight-through joint



Transformer Testing

NEW EQUIPMENT AT WALTON-ON-THAMES FACTORY



The two motor-generator sets installed by the Hackbridge & Hewittic Electric Co., Ltd., for transformer testing

To provide sufficient testing capacity for the larger transformers with capacities well above 100 MVA that are being manufactured in increasing numbers, the Hackbridge & Hewittic Electric Co., Ltd., has recently installed and commissioned two testing generators at its Walton-on-Thames factory. The equipment consists of two identical B.T.H. motor-alternator sets, a step-up transformer and ancillary apparatus, making a nominal capacity of 30 MVA available at any voltage from 20 kV to 50 kV at any power factor from 0·1 to 0·01. A full-load short-circuit heat run can now be carried out on transformers up to approximately 200 MVA. The driving motors are of sufficient capacity to permit, with the addition of capacitors across the alternators, larger transformers being tested under full-current conditions.

Power is taken from the local 11 kV supply to the factory and is fed to the two sets via a p.i.l.c.s.w.a. three-core cable to the generator house, about 150ft from the test enclosure, equipped with a 30-ton overhead electric crane, extraction fans and fluorescent lighting. Each motor is a 2,000 h.p., 1,500 r.p.m. synchronous machine with two pedestal bearings and a direct-coupled exciter, and is arranged for auto-transformer starting. A vernier type coupling is employed between the motor and alternator to permit mechanical phasing. Both motors and alternators are self-cooled by rotor fans. A motor-field regulator, field-shorting switch and discharge resistance, also instruments showing line voltage and current and excitation current, and a synchrometer, are provided in each control cubicle.

The common lubricating system for both sets includes a 750 gal sump tank with thermostatically-controlled heaters and a water-cooled heat exchanger. Provision is made to heat and circulate the oil through the bearings before starting and to cool it when running. To reduce the starting torque and hence the starting current, all bearings are fitted with individual motor-driven jacking pumps, and the starting switch is so arranged that it cannot be closed until the main oil pump as well as the jacking pumps are running. The main oil pump is driven by a d.c. motor, the supply for which is obtained from a Hewittic rectifier. The 400 V, 50 c/s supply for this rectifier as well as that for the jacking pump motors, ventilating fans, etc., is from an auxiliary 11,000/400 V transformer coupled by an isolating switch to the generator house 11 kV supply cable, independent of the general works supply.

In the unlikely event of failure of the 11 kV generator house supply, the rectifier feeding the d.c. pump motor fails, but the motor then operates from a 230 V battery floating across the rectifier. This arrangement is provided as the large sets take some 40 minutes to come to a standstill from full speed and in that time the bearings would overheat to breakdown if the full oil volume and pressure were not maintained. The supply for the generator house lighting, oil heaters, and trickle charger for the 230 V battery is taken from the works l.v. system.

The output from the alternators is taken through single-core p.i.l.c. cables to a transformer house and via isolating switches to two separate primary windings of a water-cooled transformer. This has three secondary windings per phase, two arranged in series-parallel and the third a tapped winding, the latter having 900 A capacity and the former 450 A each. With this arrangement, supplies at any voltage from 20 to 50 kV in 2·5 kV steps can be fed to the terminals of the transformer on test. The output side of the transformer is always star-connected, the neutral being earthed through the primary windings of the metering current transformers in each phase. The busbars from this transformer to the test area are in the form of copper tubes mounted on pin type insulators, and an isolating switch is included operated under the supervision of the test staff in a control gallery.

Meters and Controls

From this gallery the output of the alternators and the h.v. testing supply is controlled by pushbuttons which operate the exciter field regulator and the switches in the alternator output circuits. For each alternator set three essential meters are included on the test control panels, indicating the current taken by the alternator stators and rotors, and the stators of the motors. The current limit on any one of these meters determines the maximum power that can be taken from the alternator set. The two alternator currents are equalised when the machines are in parallel by the field control pushbutton.

Controls for the motors are in the generator house, but once the machines are started the loading and control of the alternators is carried out by the testing staff at the test area, and only the control of the power factor of the load on the 11 kV system is effected in the generator house. Overload and fault protection for the motors is incorporated, and alarms and trips for such items as lubricating oil temperature and pressure, and transformer water and oil flow are provided; also Buchholz protection and transformer oil and winding temperature indication.

D.C. CABLES

Authors' summary of a paper entitled "Gaseous Discharge Phenomena in High Voltage D.C. Cable Dielectrics," by E. C. Rogers, M.Sc., A.Inst.P., A.M.I.E.E., and D. J. Skipper, B.Sc.(Eng.), A.M.I.E.E., read before a meeting of the Supply Section of the Institution of Electrical Engineers

Interest in high voltage d.c. cables has been stimulated in recent years by a number of projects involving the interconnection of large power systems by submarine routes. Where such cable connections exceed a maximum length, which has been estimated at about 40 miles for 132 kV, a.c. transmission is made impracticable by the excessive charging current, and direct current must be used. Even when the distance involved is not too great to preclude the use of alternating current, direct current may still be preferred, as in the proposed scheme to link the British and French supply systems by a cable across the Channel, since the necessity to synchronise the frequencies of the two systems is thereby avoided.

One factor that must be considered in the design of high voltage d.c. cables is the possible effect of discharges in gas-filled cavities on the life of the dielectric. The importance of this effect under a.c. conditions has long been recognised, and has compelled the development of the modern pressure-assisted high voltage a.c. cable. With direct current, there is little doubt that discharges will be very much less frequent, and the rate of damage correspondingly less, than with alternating current. It may thus be possible to utilise thermoplastic insulants, such as polythene, which cannot as yet be operated at high a.c. stresses because of the difficulty of eliminating discharges.

Discharge Damage

To investigate this possibility, an assessment has been made of the importance of discharge damage as a mechanism of dielectric deterioration under d.c. conditions. Polythene was selected as the dielectric for study, on account of its translucence, which permitted the use of an optical method of discharge detection, and also on account of its known vulnerability to discharges.

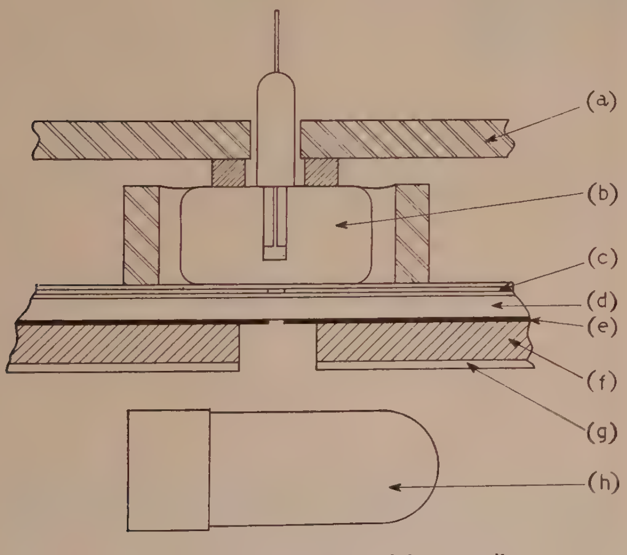


Fig. 1.—Sectional elevation of the test cell

Key: (a) *Tufnol clamping strip*
(b) *Brass h.v. electrode*
(c) *Polythene sample*
(d) *Glass plate, with transparent electrode on upper surface*
(e) *Mask*
(f) *Rubber sheet*
(g) *Lid of light-proof box*
(h) *Photo-multiplier tube*

When a dielectric containing a gas-filled cavity is subjected to a d.c. stress, there is first a rapid succession of discharges as the stress is raised from zero to the steady value, and then, with a perfect dielectric having infinite resistivity, no further discharges occur provided the stress remains steady. In practice, all dielectrics have a finite resistivity, and so repetitive discharges do occur at intervals determined by the time required for the cavity to be re-charged to the breakdown voltage by conduction through the dielectric. The steady-state repetition rate depends on the surface conductivity of the cavity walls, which is in general unknown, but is greatest when the surface conductivity is zero. This maximum rate depends primarily on the volume conductivity of the dielectric and on the ratio of the stress in the dielectric to the breakdown stress of the gas in the cavity. It is shown in the paper that under probable working conditions in a polythene-insulated high voltage d.c. cable, the maximum steady-state discharge repetition rate is unlikely to exceed ten discharges per site per hour.

Repetition Rate

To confirm the theoretical work, direct measurements of the repetition rate of discharges in air-filled cavities in polythene samples were made by means of the equipment shown in Fig. 1. The samples consisted of three sheets of polythene placed face to face, the middle sheet being punched at its centre with a circular hole, so providing the cavity. Light emitted by the discharges in the cavity was detected by the photo-multiplier tube, and the number of discharges was recorded by a simple counter circuit. In all the tests, the discharge repetition rate decreased with time until a sensibly steady value was reached after one to three days. This change in the repetition rate may be attributed to the similar variation in the volume conductivity of the polythene, which is caused by dielectric absorption.

To estimate the effect of a cavity on the d.c. life of a dielectric, it is necessary to know not only the discharge repetition rate, but also the number of discharges in the cavity which the dielectric can withstand. If this number is not greatly influenced by the frequency of the discharges, then it can be determined in a relatively short time by means of 50 c/s life tests on samples containing artificially introduced cavities. Care is needed in the design of these tests, since changes in the conductivity of the cavity walls, caused by the discharges themselves, can result in the discharges becoming extinguished or intermittent. Life tests of this kind made on polythene samples containing air-filled cavities of up to 0·1 mm depth have shown that at a temperature of 65°C, and at stresses in excess of 150 kV/cm, the polythene can withstand at least 2×10^8 discharges without failure. Hence, with a polythene-insulated high voltage d.c. cable, in which the maximum steady-state discharge repetition rate is unlikely to exceed ten discharges per site per hour, the time to failure caused by discharge damage should be greater than 10^7 hours. This is very much longer than the normal working life of a cable of about 40 years.

DISCUSSION

Mr. R. Davis (National Physical Laboratory), opening the discussion, said that the impregnated paper dielectric still appeared to be most satisfactory for d.c. cables, but the authors had pointed out that when polythene was used an external waterproof covering might not be needed. Would the existing extrusion processes be equal to the task of producing a polythene cable of large diameter ?

Mr. C. C. Garton (E.R.A.) said that a mathematical solution had long been needed, but he would like to query the sensitivity of the detection method employed. The authors had rather glossed over the question whether they were recording every discharge. Surely, over a period of hours or days, one would encounter a large random noise pulse, and thus fail to record some of the discharges. Greater emphasis could have been placed upon the danger presented by exceptionally large voids. Unless one monitored a cable as it was made these could not be detected. A discharge detector could not be relied upon: the single large discharge was apt to be lost amid the greater number of small discharges.

Mr. C. C. Barnes (C.E.G.B.) criticised the authors for dismissing Terylene and polystyrene from serious consideration on the ground of cost. Costs, he said, were always changing.

Mr. E. L. Davey (B.I. Callender's Cables) said that figures had been given on the permissible length of a cable for a.c. transmission. He would be inclined to increase them substantially but, generally speaking, economic factors were paramount in these matters. Polythene was the most promising dielectric available. Its obvious weakness lay in the fact that one had no control over the size of the voids that might occur. At depths of, say, 200 fathoms, pressure would cause voids to disappear, producing a solidly compressed polythene.

Mr. R. C. Mildner (T.C. & M.) reminded the meeting that in 1958 the discharge repetition period had been deduced as minutes or hours, compared with the previous deduction of weeks and months. The more refined theory of the paper now provided remarkable confirmation of this. It was not always true to say that the energy in the discharge increased with the size of the cavity: it was rarely true in polythene-insulated cable of high quality.

Dr. B. F. Salvage (Leeds University) suggested that more experimentation would have balanced the excellent theoretical work. A comparison of the way in which the discharge repetition rate, and the conductivity, varied with temperature would have provided a helpful check. Earlier, Mr. Rogers had published a paper on the self-extinction of gaseous discharges in cavities in solid dielectrics. There was now considerable evidence that this effect was caused by an increase in the conductivity of the surfaces of the cavities. Could not a similar process be tending to cause short-circuiting of the cavities in the experiment now described, with a consequent reduction in the discharge repetition rate ? Had the authors followed the degradation process in the walled dielectrics surrounding the discharging cavities ?

Mr. J. H. Mason (E.R.A.), though accepting the mathematics, stated that previous work at the E.R.A. had shown that numerous small sites discharged in a single cavity, and that each was of a very irregular shape. Why then, he asked, was it thought necessary to make such elaborate mathematical calculations ? The factors controlling the discharge repetition rate could obviously be very complicated. He also queried the effectiveness of the detection method employed. Would not the light emitted by the discharges have been attenuated in passing through the polythene, resulting in failure to record all discharges ? It was said that discharges in cavities adjacent to the conductors were unlikely to be extinguished, but earlier work at the E.R.A. had shown that such cavities frequently were short-circuited by carbonisation.

Mr. J. E. L. Robinson (chairman) said that though at first one gained the impression that the size of the void affected repetition frequency, when one came to the equations the dependence upon size seemed to have disappeared. He assumed that there was indeed very little critical dependence upon the precise size of the void. The most important practical case referred to was that in which one side of the void was, in fact, the conductor. He wondered whether the authors had correlated the measurements with the theory in this instance.

Mr. G. S. Buckingham (Midlands Electricity Board) observed that the authors had modestly described the predicted time to failure of the polythene-insulated high voltage d.c. cable as being very much greater than that normally to be expected. Was there any recent information on the suggestion that impregnated paper and polythene-type material might be interleaved in a lead covered cable ?

Mr. D. J. Skipper, in replying to the points raised, said that he and Mr. Rogers had emphasised the submarine uses of d.c. cable because the first commercial d.c. links had been undertaken in that sphere. He felt that the lengths of cable given were approximately those at which useful power could be transmitted. The sensitivity of the detector had been checked against other methods. Exceptionally large voids were important. It was essential that polythene cable for d.c. operation should be continuously monitored. It was perhaps wrong to omit consideration of a material such as polystyrene on the ground of cost alone. Polystyrene had an extremely high resistivity which, coupled with a fairly large variation of conductivity with temperature, could lead to very unfavourable stress distributions and adversely affect the current rate. The conductivity of Terylene changed markedly with temperature and this might result in high stress inversions under load. The "tailoring" of molecules to suit existing needs was best left to the chemist. Pressurisation was helpful but was very much less of an advantage under d.c. conditions.

Radiation Protection

A SECOND course on the principles of radiation protection is to be held at the Reactor School, Atomic Energy Research Establishment, Harwell, from 20th April to 29th June. The syllabus will be similar in content to the first course which is still in progress and ends on 26th January, but it will be modified in the light of experience gained from this first course. The course is intended for graduates or people of graduate status who are taking up work on health and safety problems in the nuclear field. It lasts for eleven weeks and visits to the U.K.A.E.A. factories at Windscale, Calder Hall, Springfields and Capenhurst will take place during the final week. Three days each week will be set aside for lectures and two days for experimental work and visits. The fee for the course is £250 and application forms may be obtained from the Principal, Reactor School, Atomic Energy Research Establishment, Harwell, Berkshire. The closing date for applications is 11th March.

COOKER THERMOSTATS

A NEW British Standard, B.S. 3180 : 1959, "Thermostats for use with domestic electric cookers," specifies requirements for the performance, testing and safety of single-pole, single-circuit thermostats used in the ovens of domestic cookers operating on supplies not exceeding 250 V a.c. to earth. Among the type tests laid down are those relating to insulation resistance and dielectric strength (both hot, and after humidity conditioning), calibration and range accuracy, and endurance. Appendices describe in detail the apparatus required for testing endurance and calibration. Thermostats purporting to comply with this standard are required to be marked with its number, i.e. "B.S. 3180." Copies are obtainable from the British Standards Institution, Sales Branch, 2, Park Street, London, W.1. Price 4s 6d.

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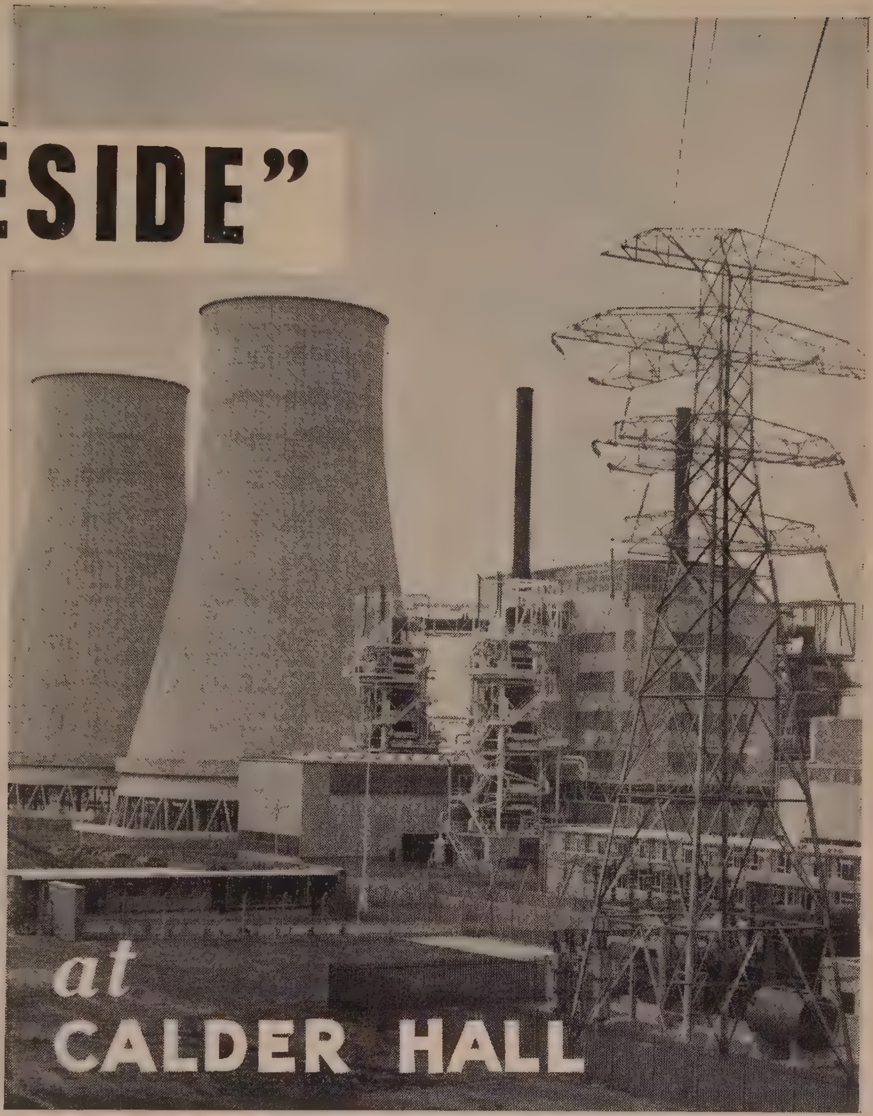

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Photo by courtesy U.K. Atomic Energy Authority

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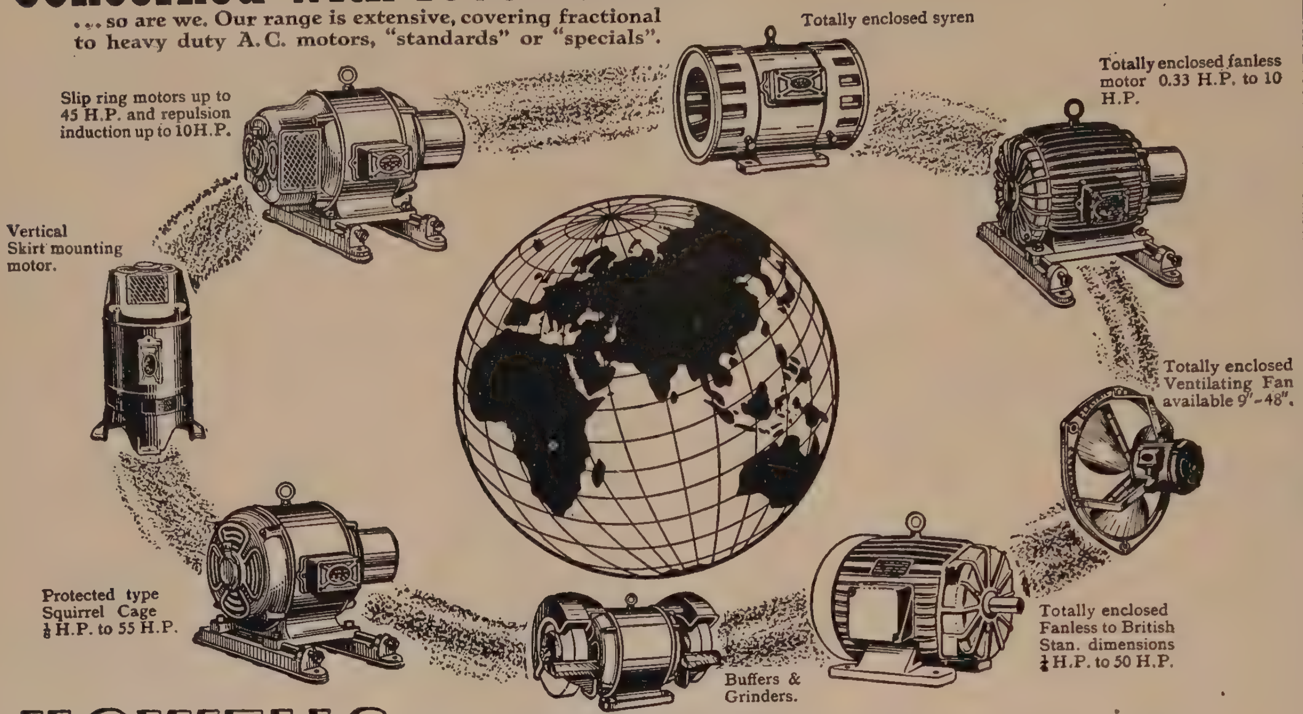
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NEW ELECTRICAL EQUIPMENT

Reflector Lamp

The mercury fluorescent reflector lamp rated at 400 W added to the range of lamps produced by the General Electric Co., Ltd., Magnet House, Kingsway, London, W.C.2, can be used in exposed and dusty situations. Specific applications include exterior floodlighting and the internal lighting of large areas in factories, steelworks and similar installations.

The lamp has a hard glass bulb and can be used in unprotected situations provided the cap and holder are shielded. A thin aluminium film is applied internally to the specially contoured bulb to give a reflector with a light distribution similar to that from a standard lamp and separate dispersive type reflector. Colour correction is achieved by a thin phosphor coating on the internal reflector. This reflector is not affected by dust accumulating on the bulb, thus maintaining the light level on the working plane. The lower part of the bulb is internally frosted for diffusion and to reduce glare. The lamp, which has a list price of £7 10s, will operate in any position with standard control gear.

"Osram" mercury fluorescent reflector lamp

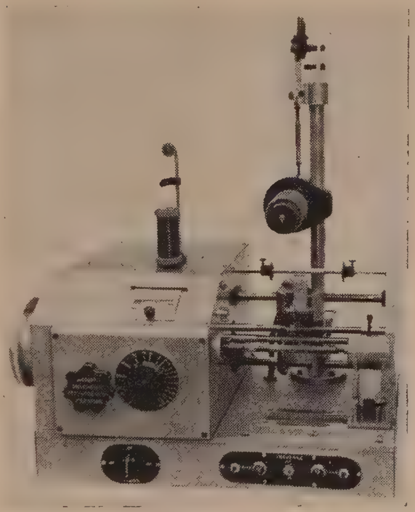
Push-button Control Stations

The range of push-button control stations for up to 550 V operation recently introduced by the Midland Electric Manufacturing Co., Ltd., Reddings Lane, Tyseley, Birmingham, 11, is described in their catalogue, List No. 446. One, two and three button, surface pattern, enclosed type units and surface-mounting, watertight types are described, together with two of the open back type flush inset pattern, one of which has received Canadian Standards Association's approval. Boxes are also available to convert these to flush fitting enclosed or conduit supported back entry pattern units. In addition there are one, two or three button, enclosed type surface-mounting general purpose units and watertight surface-mounting types which also comply with Canadian requirements and are intended for mounting on machine tools and other equipment suitable for export. Separate interiors for direct mounting within a recessed aperture on a machine or as replacements in the control stations can also be supplied.

Midland Electric watertight surface mounting control station

Coil Winding Machine

A new bench type coil winding machine being manufactured by Westool, Ltd., St. Helen's Auckland, Co. Durham, is fitted with a five-figure re-set revolution counter and can be designed with any value of maximum speed up to 4,000 r.p.m.



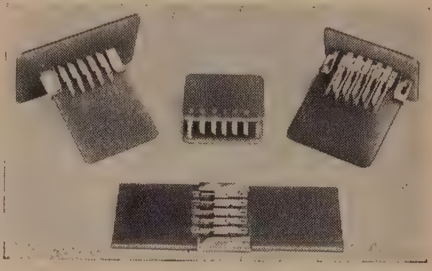
Westool coil winding machine

The rate of acceleration from zero to maximum speed is determined by a handwheel which operates a potentiometer controlling the Warner electric clutch coupled to the motor. Coils can be wound up to 5in in diameter and 3in long in gauges from 30 to 50 s.w.g. The reel carrier spindle is suitable for reels up to 6in in diameter but for the winding of fine gauges from 47 to 50 s.w.g. a small "over end feed" is also supplied.

The traversing mechanism incorporates two Warner electric brakes coupled to worm wheels in constant mesh with two lead screws. The traverse is set by adjustable stops which actuate microswitches energising and de-energising the brakes, giving positive and instantaneous reversal of direction. The wire spacing is set by a handwheel moving against a calibrated scale engraved in s.w.g. sizes or in decimals of an inch. The overall dimensions are approximately 24in long by 24in wide.

Printed Circuit Connectors

In the range of printed circuit connectors announced by N.S.F., Ltd., 31-32, Alfred Place, London, W.C.1, each connector contact has four mating surfaces. The contacts are supplied on a plastic strip positioned for the insertion of the contact legs into holes in the printed circuit board. The standard spacing of contacts is at 0·200in but other spacings may be provided at a small additional tooling cost. The maximum number of contacts on a single strip is 20 at present.



N.S.F. "Varicon" printed circuit connectors

Staking the contacts to the printed circuit is carried out with special tools which shave 0·009in of material at both sides of the contact leg, compressing this material tightly against the copper printed circuit. This staking and the subsequent dip soldering of the board results in a solid, low resistance contact, and a force of over 65 lb is required to tear a contact from the board if staked and soldered, 50 lb if staked only, and 25 lb if soldered only.

The contact material for the 5000 series connectors is phosphor-bronze finished with a nickel layer 0·0002in thick followed by 0·00002in hard gold plate, but the nickel can be replaced by silver if required. The contact resistance is 0·003 Ω maximum with nickel plate or 0·002 Ω maximum when silver plated. The contacts are rated at 5 A. A kit containing contacts, brackets and staking tool for assembling the connectors is also available.

Submersible Electric Pumps

A range of series "B" 4in submersible electric pumps has been announced by Sumo Pumps, Ltd., 28, St. James's Square, London, S.W.1, a member of the Stone-Platt Industries group. The new units, which are identified as types B11, B21 and B31, incorporate certain design improvements. The impeller has sand slinger vanes, and a higher head per stage has been obtained by the use of impellers of larger diameter. The effect of these changes is that pumps are now of simpler construction, more compact and robust and easier to service. The "Clam-Seal" motor, introduced a year ago to operate in sand-laden water, is now fitted as the standard motor for the 4in range. Motors of all sizes are now made in either single- or three-phase versions and a new motor size rated at $\frac{1}{2}$ h.p. with a 50 c/s supply has been added to the range.

Continuously Variable Transformers

The latest catalogue produced by the ZENITH ELECTRIC CO., LTD., Zenith Works, Villiers Road, Willesden Green, London, N.W.2, gives details of more than 300 models in the "Variac" series of continuously variable transformers. Among the new models of which details are given is the type "V-3H," which is designed for connection to a 240 V 50 c/s supply, although other supplies can be covered, and has an output adjustable between zero and 270 V with a rated current of 1·0 A.

For heavier loads, the series "50" can be supplied in oil-immersed form and this construction is now available for any unit where the installation requires complete protection of the winding. When mounted at the rear of a panel, a right-angle drive can be arranged or the unit can be motorised for remote control. The dual output series is now equipped with a centre tap for use in voltage control and similar applications.

All "Variac" transformers are in the form of a continuously adjustable auto-transformer and can be used as speed controllers for small motors as the normal starting currents are within the permitted overloads.

Digital Printer

An instrument for recording digital information collected by electronic scalers without destroying the scaler indication, which prints up to fourteen characters simultaneously, is announced by RADIATRON, 7, Sheen Park, Richmond, Surrey. The "Kienzle" type D1E fast digital printer operates according to an interrogation principle. On receiving the print command, its incorporated motor turns all print wheels (one for each digit) by one complete revolution, sending during this process ten interrogation pulses to the scaler, corresponding to numbers 0-9 embossed on each print wheel. These pulses are sent to all decades of the scaler simultaneously, each resulting in stepping all scaler digits on by one position. Whenever one of the scaler digits passes its "O" position it sends back to the printer a locking pulse. This locks, via an amplifier and solenoid, the corresponding print wheel in a position to match the indication of the scaler digit. The scaler itself continues to step until it again reaches its original position. The whole interrogation process takes only 90 msec. Immediately after interrogation and locking, simultaneous printing of all digits takes place.

Radiatron digital printer

The machine can print three lines of up to 14 digits each per second on 80 mm paper strip. It is also available with a tabulator in which a number of columns can be printed on a 600 mm paper roll for data logging. Translator circuits have been developed to operate the printer with dekatron, hard valve flip-flop, hot cathode indicating tube and transistorised-type scalers. It can also be used with electro-mechanical types of counting devices. A serial number can be printed alongside the record which may step automatically or may be remotely controlled.

Tunnel Diodes

Believed to be the first of their kind in Europe, tunnel diodes having a very pronounced negative resistance characteristic have been developed by STANDARD TELEPHONES & CABLES, LTD. The company is now offering devices which are at an advanced stage of their development to enable circuit designers to familiarise themselves with the new properties, and obtain early experience with the circuit performances which can be achieved. Sample devices are immediately available and are the forerunners of a range having a performance extending into the v.h.f. region. Full details can be obtained by writing to the Transistor Division at Footscray, Kent.

"Creda" Refrigerators

THE introduction of two new refrigerators, the "Creda 300" (3 cu ft) and the "Creda 475" ($4\frac{3}{4}$ cu ft), is announced by the Simplex Electric Co., Ltd., Creda Works, Blythe Bridge, Staffs. Both models are designed in the modern square cut style, with no protruding handles or hinges, and the doors open within their own width. The inside door panels include egg racks, dairy compartments and generous bottle storage space, while the internal layout has been designed for maximum storage with ample spacing between shelves for greater convenience in use. Extra large freezing compartments provide storage room for frozen foods, ice cubes, etc. The larger model additionally includes a full-width salad crisper, adjustable shelves and an interior light. Both models have scratch and heat resistant "Melamine" working tops with a splash back on which the temperature control regulator is mounted. The exterior finish is in white or cream and each is fitted with a "Tecumseh" sealed unit, voltage range 200/250 a.c.

The "Creda 475" is 36in high (excluding splash plate) by $23\frac{3}{16}$in wide by $22\frac{1}{4}$in deep, and the "Creda 300" is 33in high by $19\frac{7}{16}$in wide by $20\frac{7}{8}$in deep. For this model a plinth to raise the table top height to 36in is available as an optional extra. Supplies of the larger refrigerator will not be generally available until May and of the smaller until June. Initial production will be restricted and consequently only token supplies will be reaching the shops. Prices, including purchase tax, will be 66 gns and 52 gns respectively.

Simplex "Creda 300" refrigerator

Simplex "Creda 475" refrigerator

GENERATION and DEVELOPMENT

Area Boards' Domestic Appliance Sales

November, 1958, was the first full month of trading free from hire-purchase control and sales of domestic electrical appliances rose to a record level. Compared with this boom period the latest figures for Area Boards' sales (for November, 1959) issued by the Electricity Council naturally show a falling-off; the only rise, in fact, was in storage water heaters. Referring to the more recent monthly statements, a point of interest is the upward trend of cooker sales; in November 31,559 were sold compared with 31,318 in October and 29,776 in September. In contrast, sales of washing machines have tended to ease (12,793 in November against 14,665 in October and 16,140 in September). There were sharper falls in sales of immersion heaters and refrigerators but this was a seasonal trend.

Type of Appliance	Month ended 30th Nov.		Twelve months ended 30th Nov.	
	Total	Change %	Total	Change %
Cookers ...	31,559	− 2·3	336,553	+33·0
Water Heaters:				
Immersion...	8,141	− 6·4	190,881	+17·7
Storage ...	5,505	+10·8	59,903	+25·1
Wash Boilers...	5,005	−27·0	68,164	−15·7
Washing Machines ...	12,793	−33·9	168,377	+82·2
Refrigerators	5,515	−28·9	166,538	+138·5

Loch Ericht Power Station

The North of Scotland Hydro-Electric Board has placed a contract with A. A. Stuart & Son (Glasgow), Ltd., for the building of a power station on the eastern shore of Loch Ericht, some ten miles south of Dalwhinnie. The plant, a 2,200 kW turbo-induction generator, will be supplied by Bruce Peebles & Co., Ltd., the turbine being manufactured by the Armfield Hydraulic Engineering Co., Ltd., as sub-contractors.

The new power station will stand at the outlet of the existing tunnel from Loch Garry to Loch Ericht, part of the Rannoch section of the Grampian power scheme. It will utilise the difference in level between the two lochs, a maximum of 196ft, and will produce 10·3 million kWh annually. The civil engineering consultants for the works are Sir Alexander Gibb & Partners.

Electricity Supply Directory

The 1959-60 edition of "Electricity Undertakings of the World" (the "Red Book") is now available from Benn Brothers, Ltd., 154, Fleet Street, London, E.C.4 (price 30s, or 32s including packing and postage). In the sections dealing with British electricity supply, the power stations in England and Wales, Scotland, Northern Ireland and other United Kingdom undertakings are listed, with particulars of plant installed, generating voltage and output capacity and details of the Central Electricity Generating Board and Area Boards are given.

In the section dealing with the British Commonwealth undertakings, particulars are given of the extension of the activities of the Bombay State Electricity Board and there are many new entries. There is an index of United Kingdom power stations, a general index of places with consumers' voltages, and a personal index of names mentioned throughout the book.

First Steam Raising Unit at Hinkley Point

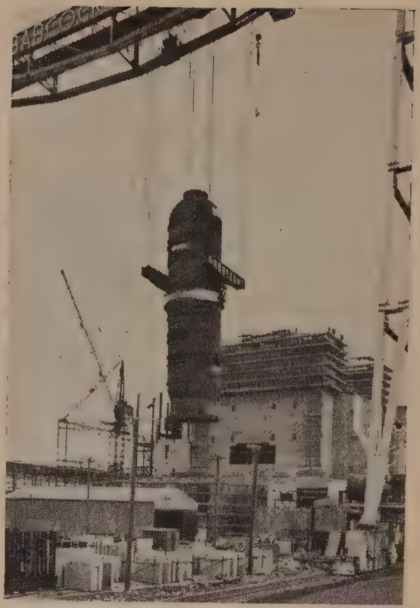
Two years after the start of construction at the Hinkley Point nuclear power station site in Somerset, the first of the twelve steam raising units to be installed has been lifted into position by the world's largest Goliath crane. The unit weighs over 300 tons and is 90ft high by 21ft in diameter. The station is being built for the Central Electricity Generating Board by the English Electric, Babcock & Wilcox, Taylor Woodrow Atomic Power Group.

Tenants to Choose

Council house tenants at Hartlepool are to be given the choice between gas or electric cookers. The borough engineer (Mr. John Wilkin) informed the Health and Housing Committee that, in the past, gas cookers had been preferred because they were cheaper, but now there was little difference in the cost.

Irish Tram at Crich Museum

A double-deck eight-wheel open-top tramcar from the Hill of Howth tramway (near Dublin), which closed on 31st May last year, is now at the Crich Tramway Museum in Derbyshire, visitors to which will be able to ride on the tram on a line being constructed by members of the Tramway Museum Society. The tram, one of ten owned by the Society, was unloaded at Liverpool on 6th January and was transported to the Museum on a lorry and trailer. The tram was built by Milnes of Birkenhead, and has electrical parts made by the British Thomson-Houston Co., Ltd. The body is made of varnished teak and although the tram is 58 years old it is in excellent condition.



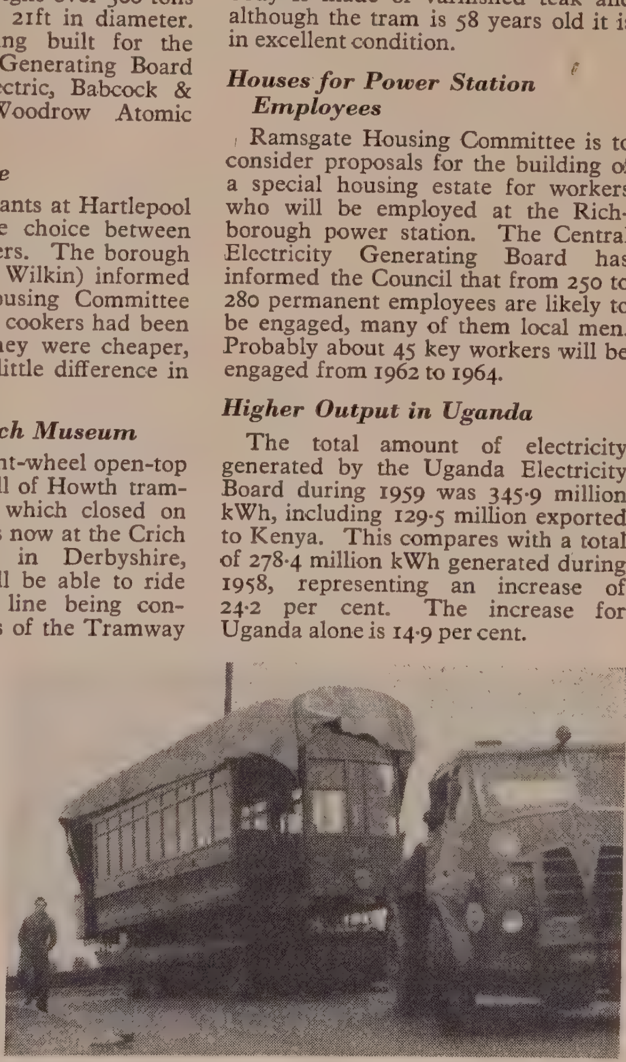
The 300-ton steam raising unit being lifted into position at Hinkley Point

Houses for Power Station Employees

Ramsgate Housing Committee is to consider proposals for the building of a special housing estate for workers who will be employed at the Richborough power station. The Central Electricity Generating Board has informed the Council that from 250 to 280 permanent employees are likely to be engaged, many of them local men. Probably about 45 key workers will be engaged from 1962 to 1964.

Higher Output in Uganda

The total amount of electricity generated by the Uganda Electricity Board during 1959 was 345·9 million kWh, including 129·5 million exported to Kenya. This compares with a total of 278·4 million kWh generated during 1958, representing an increase of 24·2 per cent. The increase for Uganda alone is 14·9 per cent.



58-year-old tram from the Hill of Howth tramway, Ireland, arriving at the Crich Tramway Museum

I.E.E. London Meetings

ARRANGEMENTS FOR THE SECOND HALF OF THE 1959-60 SESSION

THE programme of London meetings of the Institution of Electrical Engineers for the second half of the 1959-60 Session is given below. In addition to the meetings listed there are a number of other important events to note.

The Faraday Lecture on "Electrical Machines" will be given by Prof. M. G. Say at the Central Hall, Westminster, on 17th February. The annual general meeting of the Institution will be held on 19th May and will be followed by a lecture by Dr. A. M. Spooner on "Technical Features of a New Television Studio at Wembley." In association with the International Federation for Medical Electronics, the Electronics and Communications Section of the I.E.E. is taking part in the Third International Conference on "Medical Electronics," to be held at Olympia from 21st to 27th July.

Social events include the annual dinner of the Institution on 25th February at Grosvenor House, the joint dinner-dance of the Electronics and Measurements Sections on 11th March at the Café Royal, the dinner-dance of the Supply Section on 30th March at the Connaught Rooms, and the Institution Conversazione on 23rd June at the Royal Festival Hall.

The Summer Meeting of the Institution will be held from 27th June to 1st July in Scotland, and Section visits arranged are the Utilisation Section visit to Oxford from 13th to 15th May, and visits by the Supply Section to Cambridge on 21st May and to Cardiff from 29th September to 2nd October.

ORDINARY MEETINGS

28th January: "Radio Communications by Means of Satellites," by Dr. A. E. Lines.

4th February: "The Shielding of Overhead Lines Against Lightning," by Dr. J. H. Gridley.

31st March: Kelvin Lecture on "Cosmic Radiation," by Prof. C. F. Powell.

28th April: "Radar Observations of Birds and 'Angels'," by Dr. E. Eastwood.

12th May: "The Resistance of Sheet Insulation to Surface Discharges," by Dr. J. H. Mason.

INFORMAL MEETINGS

22nd February: Discussion on "Are we Making the best use of Research Resources?" opened by L. Rotherham.

14th March: Discussion on "Should Engineers be encouraged to take up Administrative Positions early in their Careers?" opened by K. E. Greene.

11th April: Discussion on "Public Lighting," opened by A. E. J. Whitcher.

EDUCATION DISCUSSION CIRCLE

23rd February: Discussion on "Courses for Electrical Technicians," opened by Prof. M. W. Humphrey Davies.

29th March: Discussion on "The Place of Illumination in Electrical Engineering," opened by G. F. Freeman.

22nd April: Discussion on "Broadening University Courses," opened by Prof. H. E. M. Barlow.

20th May: Particulars to be announced.

ELECTRONICS AND COMMUNICATIONS SECTION

27th January: "The Oral Presentation of Scientific Material," by Dr. A. Clow.

29th January: "Beam-Type Parametric Amplifiers: Some Aspects of Design and Use," by R. B. Dyott and C. R. Russell.

8th February: Discussion on "Present Views on Ground-Wave Propagation," opened by G. Millington.

24th February: "Application of Microwaves," by Prof. A. L. Cullen.

7th March: "An Introduction to the Theory of Masers with particular reference to the Travelling-Wave Maser," by Dr. P. N. Butcher.

23rd March: "The Challenge of the Propagation Medium to the Radio Engineer," by G. Millington.

4th April: "V.H.F. Sound Broadcasting: Subjective Appraisal of Distortion due to Multi-Path Propagation in F.M. Reception," by R. V. Harvey.

8th April: Symposium on Data Handling and Display Systems for Air Traffic Control.

27th April: "Henri de France Colour Television System," by R. Chaste and P. Cassagne.

2nd May: "Planning and Installation of the Sound Broadcasting Headquarters for the B.B.C.'s Overseas and European Services," by F. Axon and O. H. Barron.

25th May: Discussion on "New Semiconductor Devices and their possible Applications," opened by Dr. A. F. Gibson and G. King.

21st-27th July: Third International Conference on Medical Electronics. Electronics and Communications Section in association with the International Federation for Medical Electronics. (At Olympia.)

MEASUREMENT AND CONTROL SECTION

2nd February: "Development of the Formulæ of Electromagnetism in the M.K.S. System," by Dr. P. Vigoureux.

16th February: Discussion on "Soviet Control Engineering Progress," opened by R. E. Clark.

1st March: Lecture on "Digital Computer Developments at Manchester University," by Dr. T. Kilburn, supported by three papers.

15th March: "Fast-Response Transistor Chopper-Type Amplifier with Low Carrier Frequency," by I. C. Hutcheon and D. Summers.

5th April: "Thermistors—their Theory, Manufacture and Application," by Dr. R. W. A. Scarr and R. A. Setterington.

26th April: "An Experimental Transistor-Controlled Component Selection and Testing Machine," by T. C. Cardwell, J. R. W. Smith and G. H. King.

3rd May: Discussion on "Teaching and Learning Machines," opened by C. E. G. Bailey.

SUPPLY SECTION

10th February: "The Design of Housing-Estate Distribution Systems using a Digital Computer," by Dr. R. L. Grimsdale and P. H. Sinclaire; and "The Logical Design of Electrical Networks using Linear Programming Methods," by U. G. W. Knight.

9th March: "The Impulse Strength of Impregnated-Paper Dielectrics as used in High-Voltage Cables," by Dr. B. Salvage and J. A. M. Gibbons.

16th March: "An Electrostatic Dust Monitor," by Dr. D. H. Grindell.

13th April: "Water-Turbine-Driven Induction Generators," by C. L. C. Allan.

11th May: Annual lecture on "The Development of the 400 kV Network in Sweden," by G. Jancke.

UTILISATION SECTION

18th February: "Electricity in the Manufacture of Hydrogen Peroxide," by B. E. A. Vigers and R. O. Fletcher.

10th March: "Some Considerations in the Application of Power Rectifiers and Convertors," by J. P. McBreen.

7th April: "Novel Methods of Speed Control Applied to Standard Three-Phase Squirrel Cage Induction Motor," by G. K. Creighton and W. M. Somerville; "Preset Screwdown Control in Steel Rolling Mills," by R. M. Epps; and "Linear Electrical Machines," by P. J. Lawrenson.

5th May: Annual lecture on "Safety in the Utilisation of Electricity," by S. J. Emerson.

MEDICAL ELECTRONICS DISCUSSION GROUP

5th February: Discussion on "Computers in Medical Use," opened by Dr. R. A. Buckingham and Dr. J. M. Tanner.

4th March: Discussion on "Direct Writing Oscillographs," opened by A. Smale and S. N. Pocock.

12th April: Discussion on "Aids for the Blind," opened by Lord Fraser of Lonsdale and Dr. R. L. Beurle.

6th May: Discussion on "Methods of Recording Measurements—Digital or Analogue," opened by W. J. Perkins.

JOINT MEETING

3rd March: Graham Clarke Lecture on "The Engineer and Civilisation," by Sir Hugh Beaver. (Joint meeting with the I.C.E. and I.Mech.E.)

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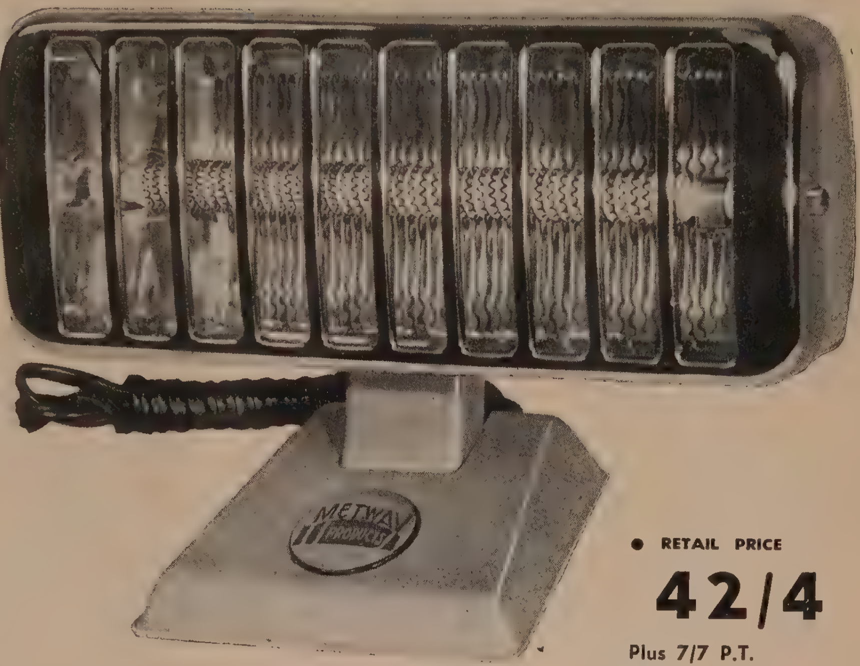

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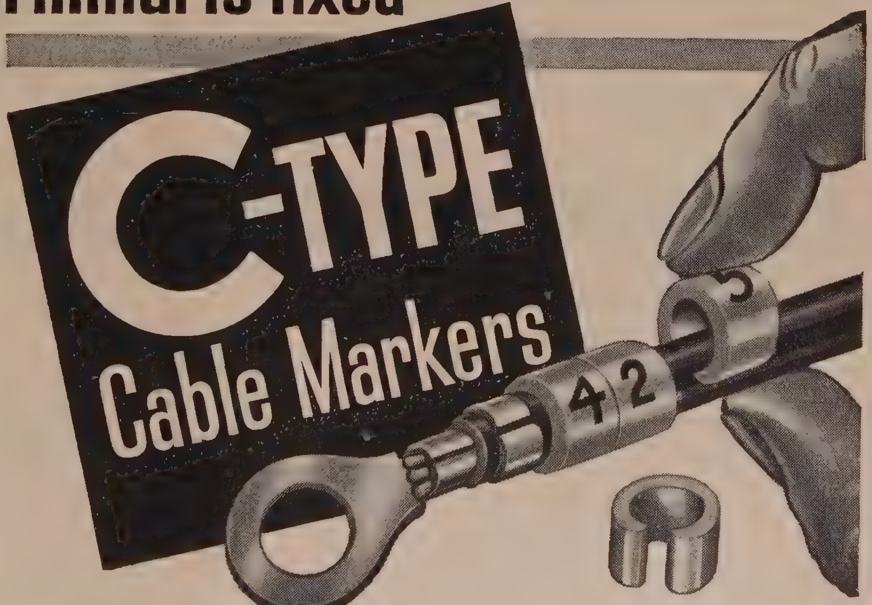

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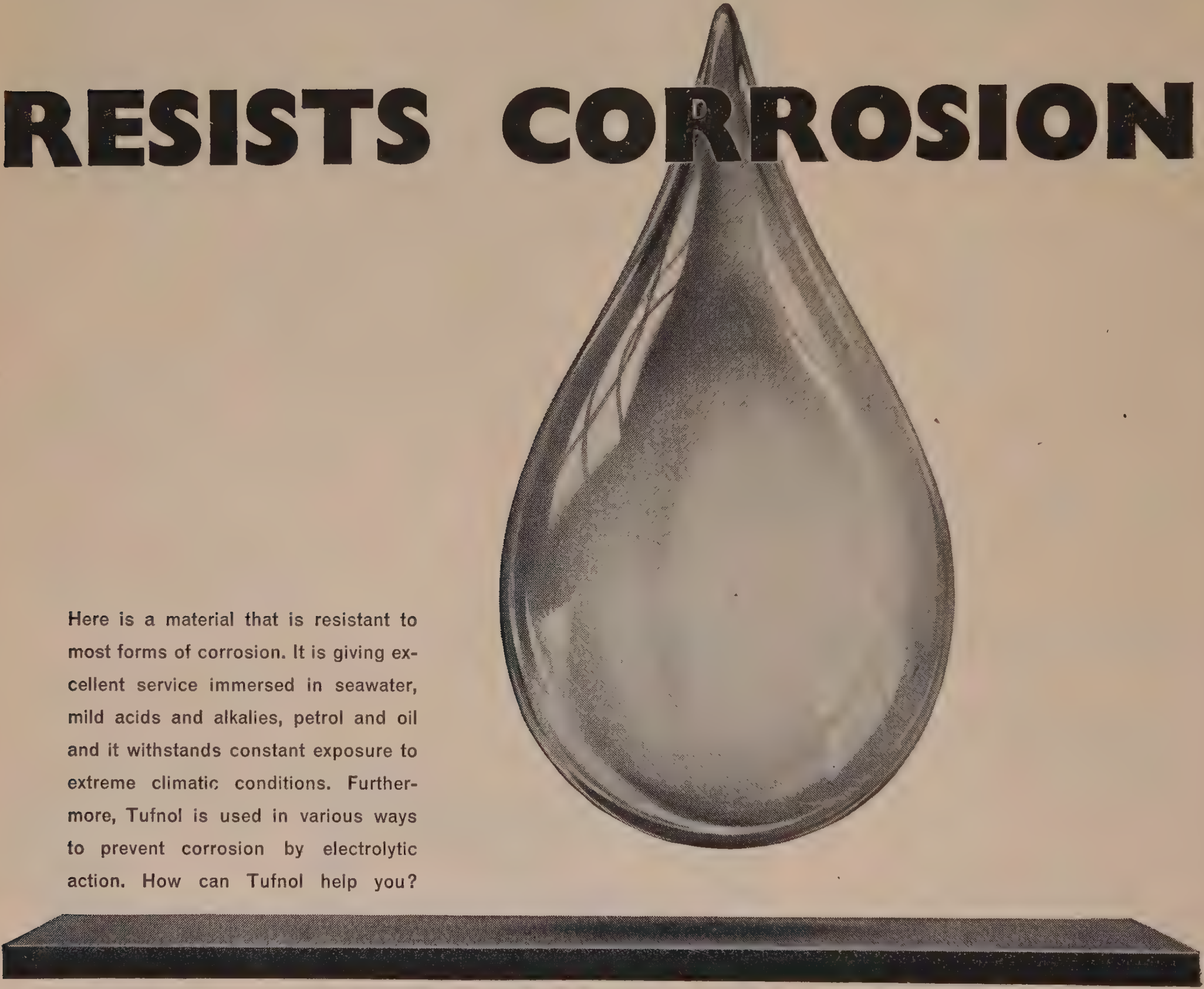

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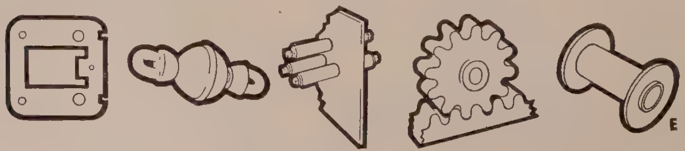

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NEXT WEEK'S EVENTS

Organisers of electrical functions are advised to make use of the “Electrical Review” clearing house, Room 221, Dorset House, Stamford Street, London, S.E.1, to ascertain that proposed dates for their functions do not clash with others already arranged

MONDAY, 25th JANUARY

Birmingham.—James Watt Memorial Institute, 6 p.m. I.E.E. South Midland Electronics and Communications Group. “Long-Distance Waveguide Transmission,” by F. J. D. Taylor. (Joint meeting with Birmingham Centre of I.P.O.E.E.)

Bennett Hall, Y.M.C.A., Snow Hill, 6 p.m. I.E.S. Birmingham Centre. “Domestic Lighting,” by D. W. Durrant. (Ladies invited.)

Bristol.—S.W.E.B. Demonstration Theatre, Colston Avenue, 6 p.m. I.E.E. Western Utilisation Group. “A Review of Electric Drives for Cranes,” by L. J. Roberts.

University of Bristol, Department of Physics, The Royal Fort, 7.30 p.m. Society of Instrument Technology, Bristol Section. “Transistors in Instrumentation.”

Chester.—Town Hall, 6.30 p.m. I.E.E. Mersey and North Wales Centre. “Characteristics and Protection of Semiconductor Rectifiers” by D. B. Corbyn and N. L. Potter.

Ipswich.—Electric House, 6.30 p.m. I.E.E. East Anglian Sub-Centre. “Radio Interference from H.V. Insulators,” by Dr. C. H. W. Clark.

Leeds.—At the British Lighting Council, 24, Aire Street, 6.15 p.m. I.E.S. Leeds Centre. “Some Recent Developments in Street Lighting,” by N. Burgess.

Leicester. — Demonstration Theatre, E.M.E.B., Charles Street, 7 p.m. I.E.S. Leicester Centre. “Recent Developments in Light Sources,” by D. H. Holloway.

London.—Savoy Place, W.C.2, 6.30 p.m. I.E.E. London Graduate and Student Section. “Transistors in Switching Circuits,” by M. Paskins.

Manchester.—College of Science and Technology, Sackville Street, 7.15 p.m. Institution of Production Engineers, Manchester Branch. “Practical Applications on Operational Research,” by A. J. R. Veale.

Newcastle-on-Tyne.—Neville Hall, Westgate Road, 6.15 p.m. I.E.E. North Eastern Centre. “Field Suppression of Turbo-Alternators,” by J. R. Hill, A. Hunt, W. J. Joyce and D. H. Thompsett.

Stoke-on-Trent.—Grand Hotel, Hanley, 7.30 p.m. Institution of Production Engineers, Stoke-on-Trent Branch. “Materials Handling—A Challenge to British Industry,” by A. G. Hayek.

Watford.—Compass Hotel, 8.15 p.m. A.S.E.E. North West London Branch. “Control Gear,” by R. F. Mathieson.

TUESDAY, 26th JANUARY

Broadstairs.—Clarendon Hotel, 8 p.m. A.S.E.E. East Kent Branch. “The Decca Navigational System,” by B. A. A. Smye-Rumsby.

Cardiff.—At the South Wales Institute of Engineers, Park Place, 7.30 p.m. Institution of Plant Engineers, South Wales Branch. “Safety in Uses of Industrial Gases and Equipment,” by M. T. Reeks.

Coventry.—Training Office, G.E.C., Stoke, 7 p.m. I.E.E. South Midland Graduate and Student Section. “Information Storage,” by D. I. Williams.

Glasgow.—Royal College of Science and Technology, George Street, 6 p.m. I.E.E. South West Scotland Sub-Centre. Measurement and Control Section Chairman's address, “The Relationship of Physical Mechanisms to Psychological Processes,” by Prof. A. Tustin.

London.—Electrical Association for Women, London Branch, 2.45 p.m. Visit to the G.E.C., Magnet House, Kingsway, W.C.2.

Manchester.—Engineers' Club, Albert Square, 6.15 p.m. I.E.E. North Western Supply Group. “Research on the Performance of High-Voltage Insulators in Polluted Atmospheres,” by Dr. J. S. Forrest, P. J. Lambeth and D. F. Oakeshott.

Engineers' Club, Albert Square, 5.30 p.m. E.I.B.A. Manchester and District Branch. Annual general meeting.

Engineers' Club, Albert Square, 2.30 p.m. Combustion Engineering Association, North Western Region. “The Utilisation of Steam and Heat,” by R. Clare.

Newcastle-upon-Tyne.—Roadway House, Oxford Street, 7.30 p.m. A.S.E.E. Newcastle-upon-Tyne and District Branch. Film of the 1959 Electrical Engineers (A.S.E.E.) Exhibition and travel films. (Ladies invited.)

Rugby.—College of Technology and Arts, 6.30 p.m. I.E.E. Rugby Graduate and Student Section. “Some Vibration Problems in Engineering,” by E. Tudor.

Swansea.—Beaufort Hall, Mackworth Hotel, 7 p.m. Ministry of Works. “Electric Floor Warming,” by E. W. Faithfull.

WEDNESDAY, 27th JANUARY

Bristol.—At the School of Management Studies, Unity Street, 7 p.m. Institution of Radio Engineers, South Western Section. “An Equipment for Automatically Processing Time Multiplexed Telemetry Data (Timtape),” by R. O. R. Chisholm.

Cardiff.—Welsh College of Advanced Technology, 6.45 p.m. Society of Instrument Technology, South Wales Section. “The Basic Principles of Digital Instrumentation,” by D. S. Evans.

Edinburgh.—Carlton Hotel, North Bridge, 7 p.m. I.E.E. South East Scotland Sub-Centre, Measurement and Control Section. Chairman's address, “The Relationship of Physical Mechanisms to Psychological Processes,” by Prof. A. Tustin.

Royal British Hotel. Combustion Engineering Association, Scottish Region. 10 a.m. Discussion on “The Utilisation of Waste Products as Fuel,” opened by H. A. Mercer. 2 p.m. Discussion on “Fuel Saving Schemes,” opened by R. Bunting.

London.—Savoy Place, W.C.2, 5.30 p.m. I.E.E. Electronics and Communications Section. “The Oral Presentation of Scientific Material,” by Dr. A. Clow.

Connaught Rooms, W.C.2, 12.30 for 12.55 p.m. Batti-Wallahs' Society. Luncheon. Guest speaker, Sir John Simpson.

London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, W.C.1, 6.30 p.m. British Institution of Radio Engineers. “Training for Operating and Maintaining Television Broadcasting Equipment,” by Dr. K. R. Sturley and A. E. Robertson.

Nottingham.—College of Arts and Crafts, Waverley Street, 6.30 p.m. I.E.E. East Midland Centre. “D.C. Winder Drives using Mercury-Arc Rectifier/Invertors,” by L. Abram, J. P. McBreen and J. Sherlock.

Shrewsbury.—Shrewsbury Technical College, Oakengates, 7.30 p.m. Institution of Production Engineers, Shrewsbury Branch. “Automatic Transfer Machines,” by R. Cadwallander.

Grangemouth.—“Ellwyn” Restaurant, Newlands Road, 7 p.m. Society of Instrument Technology, Grangemouth Section. “Computer Control of a Continuous Process Plant.”

Hove.—New Imperial Hotel, 7.30 p.m. A.S.E.E. Brighton, Hove and District Branch. “Switchgear Testing,” by R. Jones.

Lincoln.—Ruston Club, 7.30 p.m. Institution of Production Engineers, North Midlands Region. “Some Aspects of Production Engineering,” by L. R. Mumford.

Liverpool.—The University, 7 p.m. Institution of Plant Engineers, Merseyside and North Wales Branch. “Steam Supplies from a Central Back-Pressure Plant to an Integrated Group of Factories,” by J. B. Lancaster.

London.—Savoy Place, W.C.2, 5.30 p.m. I.E.E. Ordinary meeting. “Radio Communications by Means of Satellites,” by Dr. A. W. Lines.

Sheffield.—Grand Hotel, 7.30 p.m. Institution of Plant Engineers, Sheffield and District Branch. “Instrumentation,” by Dr. R. H. Baulk.

Southampton.—Polygon Hotel, 8 p.m. A.S.E.E. Southampton Branch. “Impregnating Varnishes and Wire Enamels,” by K. B. Smith.

Warrington. — M.A.N.W.E.B. Service Centre, Buttermarket Street, 6.30 p.m. I.E.E. Mersey and North Wales Centre. “The Electrification of the U.K.A.E.A. Industrial Group Factories,” by J. W. Binns and W. J. Outram.

Weymouth. — South Dorset Technical College, 6.30 p.m. I.E.E. Southern Centre. “Nuclear Physics—The Elementary Particles,” by Dr. G. N. Fowler.

THURSDAY, 28th JANUARY

Cardiff.—Park Hotel, 10.30 a.m. and 2.30 p.m. Combustion Engineering Association, Western Region. Discussion on “Factors Affecting the Choice of new Boiler Plant,” oened by W. Short.

Chester.—At the English Speaking Union, Stanley Place, Watergate Street, 7 p.m. Society of Instrument Technology, Chester Section. “The Application of Method Study to Instrument Maintenance,” by D. L. Smith.

Croydon.—Greyhound Hotel, High Street, 8 p.m. A.S.E.E. South London Branch. “The Work of the Royal Mint Refineries,” by J. T. McEvoy.

Glasgow.—Bute Hall, The University, 7.30 for 8 p.m. I.E.E. Scottish Centre. Diamond Jubilee Conversazione.

FRIDAY, 29th JANUARY

Belfast.—Grand Central Hotel, 7.15 p.m. I.E.E. Northern Ireland Centre. Annual dinner-dance.

Birmingham.—Imperial Hotel, Temple Street, 7.30 p.m. Institution of Plant Engineers, Birmingham Branch. Open forum.

Brighton.—Grand Hotel, 6.30 for 7 p.m. E.I.B.A. Sussex Centre. Annual ball.

Coventry.—E.M.E.B. Sports and Social Club, Merrick Lodge, Sandy Lane, 7.45 p.m. A.S.E.E. Coventry and District Branch. Visit of Mr. C. G. F. Aldridge (chairman) and Mr. E. A. Bromfield (general secretary).

Farnborough.—Salesian Hall, Peabody Road, 7.30 p.m. A.S.E.E. Aldershot and District Branch. Social evening.

Glasgow.—Building Centre, Sauchiehall Street, 7.15 p.m. Society of Instrument Technology, Scottish Section. “Computer Control of a Continuous Process Plant.”

London.—Savoy Place, W.C.2, 5.30 p.m. I.E.E. Electronics and Communications Section. “Beam-Type Parametric Amplifiers: Some Aspects of Design and Use,” by R. B. Dyott and C. R. Russell.

Newcastle-upon-Tyne. — King's College, 6.30 p.m. I.E.E. North Eastern Graduate and Student Section. Students' lecture. “Something for Nothing? Heat Pump Achievements,” by G. O. McLean.

County Hotel, Neville Street. I.E.S. Newcastle-upon-Tyne Centre. Annual dinner-dance.

Northampton.—Overstone Country Club. Northampton and District Electrical Association. Annual dinner-dance.

SATURDAY, 30th JANUARY

London.—Women's Engineering Society, London Branch. New Year luncheon.

Manchester.—Café Royal. Institution of Plant Engineers, Manchester Branch. Ladies' evening.

CONTRACT INFORMATION

Accepted Tenders and Prospective Electrical Work

CONTRACTS OPEN

Where "Contracts Open" are advertised in our "Official Notices" section the date of the issue is given in parentheses

Altrincham.—Corporation. 5th February. Street lighting equipment. (See this issue.)

Australia.—State Electricity Commission of Western Australia, Perth. 28th January. Eighteen 66 kV, 1,000 MVA outdoor type circuit-breakers with control and relay boards. (E.S.B. 2888o/59.)*

Postmaster General's Department, Melbourne. 4th February. Armatures, buffer blocks, armature fixing screws, coils. (E.S.B. 330/60.)* 11th February. Electricity subscribers' meters. (E.S.B. 399/60.)*

Birkenhead.—Corporation. 13th February. Electrical equipment for one year to the Municipal Transport Department. General manager, Transport Department, Laird Street.

Bridlington.—Corporation. 5th February. Supply and installation of two sets of duplicate pumping plant, electrically operated and automatically controlled. Water engineer and manager, 11, Marton Road.

Durham.—County Council. Electrical installations in schools. (See this issue.)

Egypt.—Egyptian Railways Administration, Cairo. 10th February. Electrical materials. (E.S.B. 578/60.)*

General Director of Mechanics and Electricity. 9th February. Supply and setting up of a 6,300 V three-phase network. (E.S.B. 579/60.)*

Formosa.—Central Trust of China, Taipei. 23rd February. 45 kVA generator, air conditioning equipment, vacuum cleaner, etc. (E.S.B. 662/60.)*

Grimsby.—Town Council. 13th February. Electrical installations required in the remodelling of Edward Primary School, Edward Street. J. V. Oldfield, borough architect, Municipal Offices, Town Hall Square.

Hemel Hempstead.—Corporation. 1st February. Repairs to time switches (Form No. 19) and electric lamps (Form No. 21), for the year 1960-61. A. H. Turner, borough engineer, High Street.

High Wycombe.—Corporation. 17th February. Class "A" street lighting equipment. (See this issue.)

Hornsey.—Borough Council. 8th February. Annual supply of sodium discharge lamps. (See this issue.) Fluorescent lighting fittings for schools. (See this issue.)

India.—West Bengal State Electricity Board, Calcutta. 1st March. Two 9,000 kW turbo-alternator sets for Jaldhaka hydro-electric project. (E.S.B. 674/60.)*

Madras State Electricity Board. Pumping sets for Sandynallah Reservoir scheme. (E.S.B. 585/60.)*

Kanpur Electricity Supply Administration. 24th February. 3,300 V and 400 V auxiliary switchgear at Riverside power station. (E.S.B. 522/60.)*

Iran.—Taj Trading Corporation, Teheran. 30th January. 500 electrically operated room air conditioners. (E.S.B. 684/60/I.C.A.)*

Korea.—Government Office of Supply, Seoul. 4th February. Stores, including furnaces, refrigerators, electrical apparatus and water heaters. (E.S.B. 357/60/I.C.A.)* 8th February. Radio transmitters and receivers and equipment, electrical apparatus, etc. (E.S.B. 366/60/I.C.A.)*

London.—Metropolitan Water Board. 4th February. Electric lamps and fluorescent tubes (Form No. 24), for the year ending 31st March, 1961. Chief engineer, offices of the Board, Room 171, New River Head, Rosebery Avenue, E.C.1.

Nottinghamshire.—County Council. 4th March. Street lighting equipment. (See this issue.)

Old Fletton.—U.D.C. 12th February. Equipment for improved street lighting. (See this issue.)

Omagh (Co. Tyrone).—5th February. Electrical installation in voluntary intermediate school for girls. Varming & Mulcahy, consulting engineers, 37, Malone Road, Belfast.

Rhodesia and Nyasaland.—Federal Tender Board, Causeway. 28th January. Forty-five 100 kVA transformers. (E.S.B. 246/60.)* Overhead line material. (E.S.B. 247/60.)*

Salisbury Electricity Department. 23rd February. Test room equipment. (E.S.B. 517/60.)*

Solihull.—Corporation. 10th February. Electrical fittings (Form No. 7) and electric lamps (Form No. 8), for the year ending 31st March, 1961. Borough surveyor, 90, Station Road.

South Africa.—Johannesburg City Council. 8th February. Distribution transformers. (E.S.B. 640/60.)*

Durban Corporation. 12th February. Twelve 15 kVA, twenty 25 kVA and twenty 50 kVA transformers. (E.S.B. 334/60.)*

Union Tender Board, Pretoria. 27th April. Installation of h.f. radio telephone and telegraph equipment. (E.S.B. 361/60.)*

Stores Department, South African Railways, Johannesburg. 8th April. Traction substation convertor and remote control equipment for 3,000 V d.c. electrification. (E.S.B. 621/60.)*

Stoke-on-Trent.—Corporation. 1st February. Electric lamps (Form S), for the year ending 31st March, 1961. City engineer, Town Hall.

Thetford.—Corporation. 15th February. Group "A" street lighting equipment. (See this issue.)

WORK IN PROSPECT

Particulars of new works and building schemes for the use of electrical installation contractors and traders. Publication in this section is no guarantee that electrical work is definitely included. Alleged inaccuracies should be reported to the Editors

Crewe.—Houses, Middlewich Street estate (80) and in Naylor Street (60); borough engineer, Municipal Buildings.

Cumberland.—Police houses (21), old people's homes at Workington and Ennerdale, and fire station at Maryport; county architect, 15, Portland Street, Carlisle.

Grangemouth. — Works extensions (£40,000); Union Carbide, Ltd., Bo'ness Road.

Guildford.—Departmental stores, High Street, for Debenhams, Ltd.; George Baines & Syborn, architects, 121, Victoria Street, London, S.W.1.

Haslemere.—Church, King's Road, Fernhurst; A. B. Knapp-Fisher, architect, 9, Gower Street, London, W.C.1.

Hastings.—Works and offices; Central Engineering Works, Ltd., The Ridge.

Hayes.—Works extensions; M. & W. Components, Ltd., Printing House Lane.

Hendon.—Dwellings (287), Granville Road area; borough engineer.

Henley-on-Thames.—Development scheme for Borocourt Hospital; Harding, McDermott & Partners, consulting engineers, 17, Doughty Street, London, W.C.1.

Hexham.—Stores; W. Robb & Son, Ltd., Fore Street.

Kettering.—Methodist church, Grange estate; A. P. Lewis & Sons, Ltd., Duke Street, Burton Latimer.

Kidderminster. — Warehouse extension (£50,000); Carpet Trades, Ltd., Mill Street.

Leeds.—Houses, Dixon Lane/Greenside Road/Lower Wortley Road site (247) and Woodhouse Street/Servia Hill area (206); city architect, Priestley House, Quarry Hill, 9.

London.—Dwellings (524), Acorn Place area, Camberwell; borough architect.

Offices, Great Portland Street, St. Marylebone; R. Seifert & Partners, architects, 28, Great Ormond Street, W.C.1.

Maidstone.—Houses and old persons' flats (300); borough engineer, Palace Avenue.

Newcastle-on-Tyne.—Additions to the College of Further Education; R. W. Gregory & Partners, electrical consultants, Pilgrim House, Pilgrim Street, Newcastle.

Northampton.—Town Hall extensions (£250,000); borough architect.

Flats (141), in two 12-storey blocks, Althorp Street/Herbert Street site; borough architect, Guildhall.

Redcar.—Flats and houses (149); Fredk. Gibberd, architect, 19, The Rows, Harlow.

Runcorn.—Dwellings (96), Heath Road; Metropolitan Railway Country Estates, Ltd., 553, Harrow Road, London, W.9.

Selkirk.—Houses (55), Bannerfield scheme; Basil Spence & Partners, architects, 40, Moray Place, Edinburgh.

Somerset.—New farm institute at Cannington (£120,000); R. O. Harris, county architect, Park Street, Taunton.

Southampton.—Nine-storey office block, Civic Centre Road; Oliver Carey, architect, 1, Dale Close, Gosmore Road, Hitchin.

Stirlingshire.—Technical college at Randyford, Falkirk; county architect, County Offices, Viewforth, Stirling.

Stockton-on-Tees.—Factory, North Tees industrial estate, for Serck Radiators, Ltd.; J. G. L. Poulson, architect, 54, Albert Road, Middlesbrough.

Stowmarket.—Additions and alterations to main block, new nurses' home and subsidiary buildings at Stow Lodge Hospital (£129,400); Guy Aldis, regional architect to Hospital Board, 33, Parkside, Cambridge.

Swansea.—Factory extension; Servitor Brush Co., Ltd., Fforestfach Trading Estate.

Swindon.—Factory and offices for Deloro-Stellite, Ltd.; Silk & Frazier, surveyors, 35, Portland Road, Edgbaston, Birmingham.

Teignmouth.—Flats (42), Fourth Avenue; Louis de Soissons, architect, 12, Baring Crescent, Exeter.

Urmston. — R.C. secondary school (£104,000); Mather & Nutter, architects, 3, Chepstow Street, Manchester.

Uxbridge.—Showrooms and offices; Davy's Services, Ltd., 12, Vine Street.

Wallsend.—Shops on site of Royal Cinema, High Street (£40,000); John T. Bell & Sons, builders, Market Street Chambers, Newcastle-on-Tyne.

Laboratory block and factory building; Commercial Plastics, Ltd., Stephenson Street.

Watford.—Factory and offices; Barr Mason, Ltd., Leavesden High Road.

Wembley.—Old people's hostel, Copland Avenue; Anglo-Scottish Construction Co., Ltd., 112a, Coombe Lane, S.W.20.

Whickham (Co. Durham).—Secondary modern school; county architect, South Street, Durham.

Swimming baths, Dunston; U.D.C. surveyor.

Wigan.—Houses (50), Wilfred Street site; G. Keighley, borough engineer, Municipal Buildings, Library Street.

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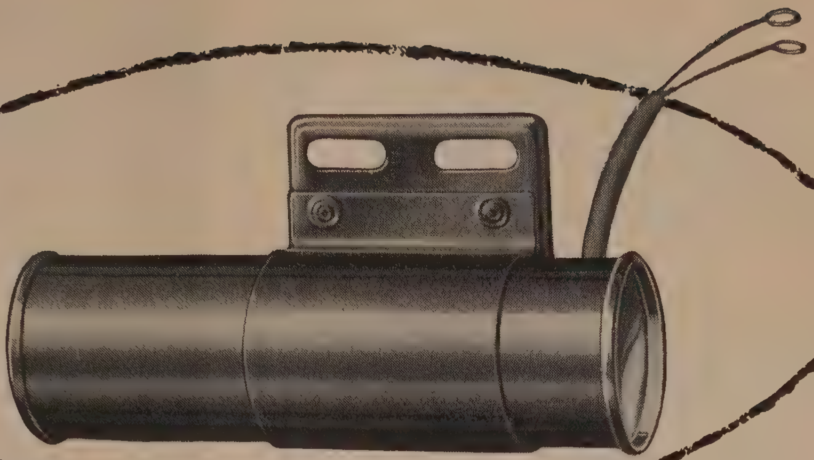
* This information is extracted from the Board of Trade *Export Service Bulletin.* Inquiries should be addressed to the Board of Trade, Export Services Branch, Lacon House, Theobald's Road, London, W.C.2 (Telephone: Chancery 4411, Ext. 738), quoting the reference given.



Off to a good start—every time

Dubilier Motor Starting Capacitors are tough and reliable. The capacitor element is hermetically sealed in an aluminium container, which is in turn housed in a seamed, metal outer casing with a strong mounting bracket.
Available in three ranges:—
150V: from 45 to 280μF. 275V: from 15 to 130μF.
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They are suitable for operation at temperatures up to 60°C.

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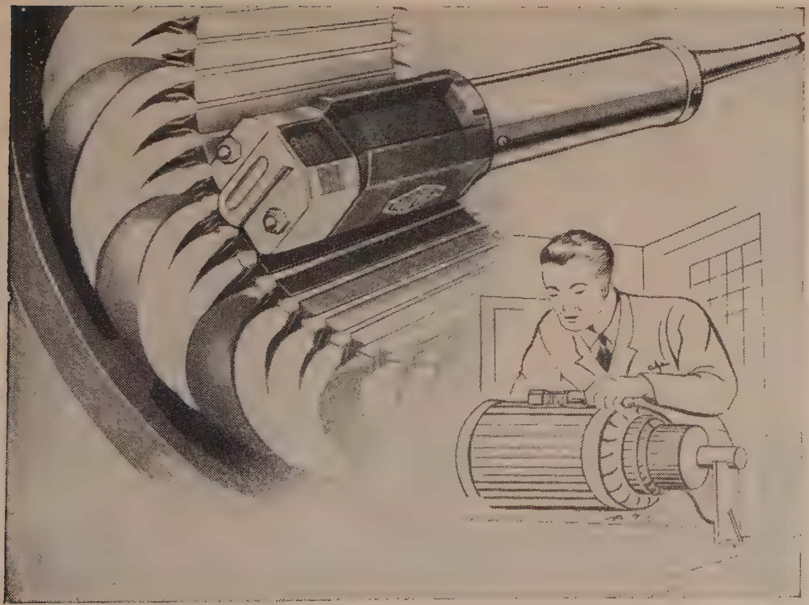
MARTINDALE



'Prufrex' A6 TESTER

A new sensitive universal fault finder.
Will test largest alternator or
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Locates short circuit—open coil—
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Immediate delivery.

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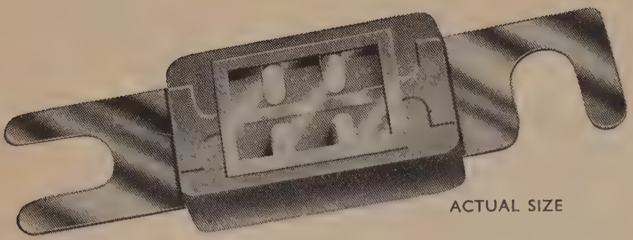

ACTUAL SIZE

Air to ground

"BELLING-LEE"

'AIRFUSE'

L1330

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Although developed for aircraft use, and approved by the A.R.B. as an equivalent to the American "Current Limiter", it has many "down to earth" applications.

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In conformity with British Standards Specification 1670

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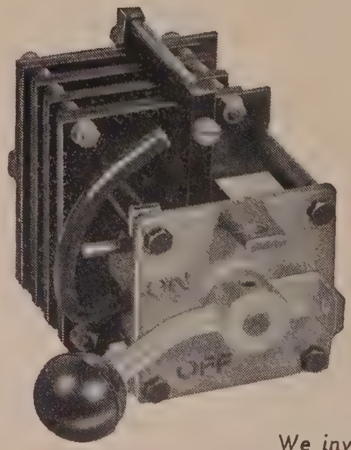

We invite your enquiries

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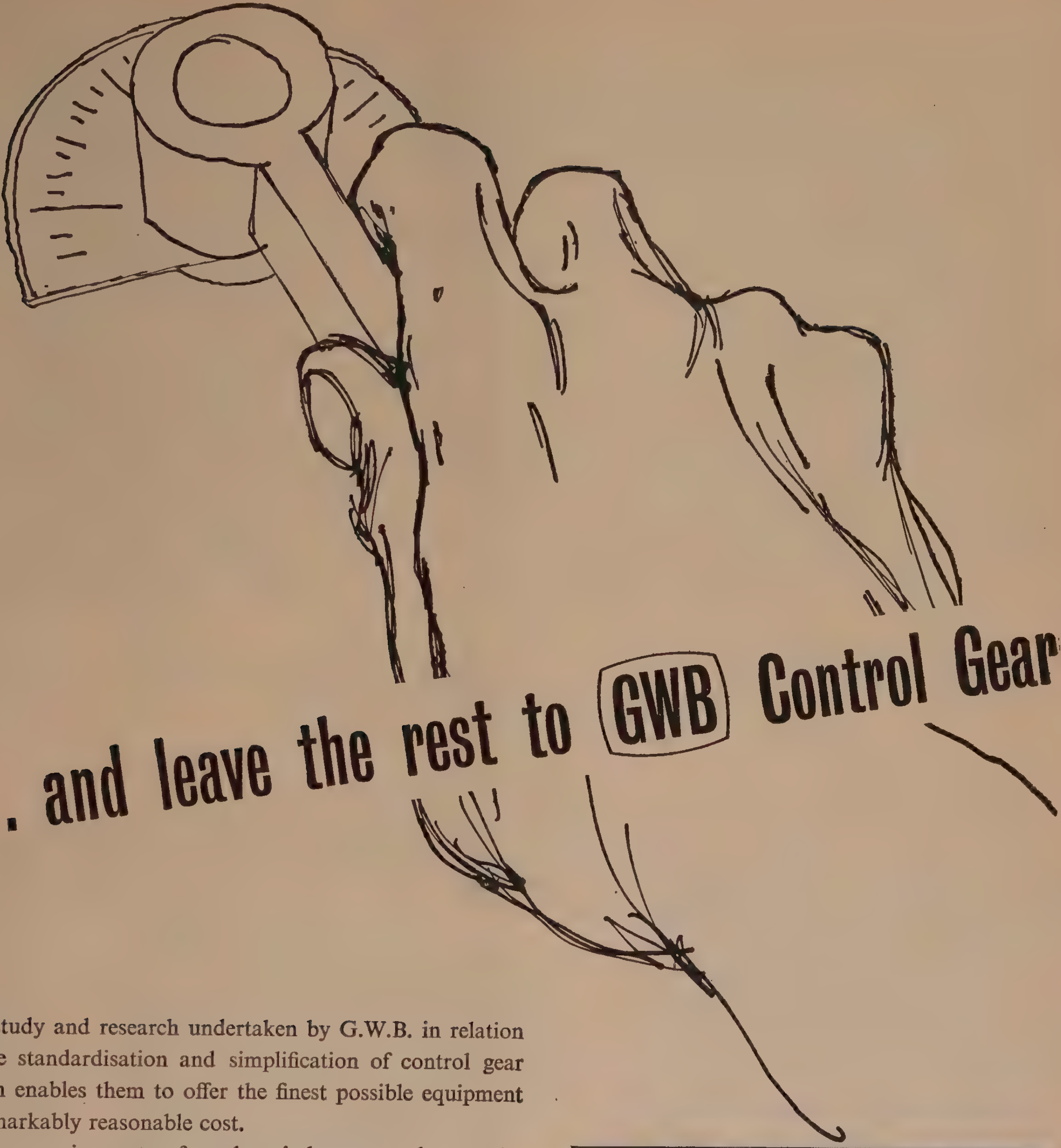

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The study and research undertaken by G.W.B. in relation to the standardisation and simplification of control gear design enables them to offer the finest possible equipment at remarkably reasonable cost.

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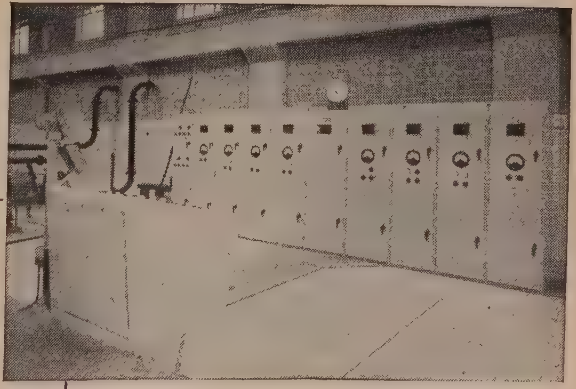

G.W.B. control panel and associated control desk in a large pumping station. Pumping station control equipment has been supplied for heavy industrial duties and also to Waterworks and Sewage stations.

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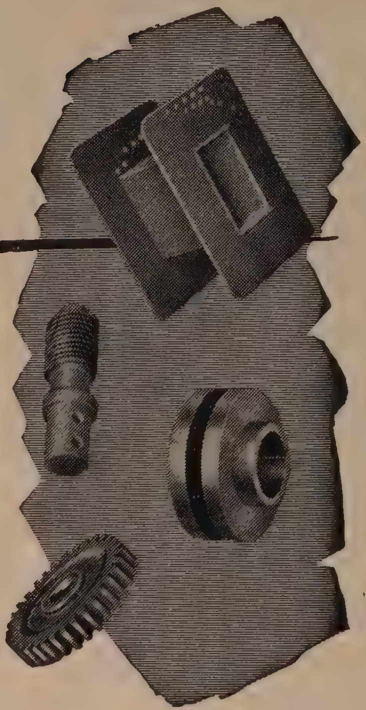

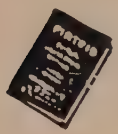

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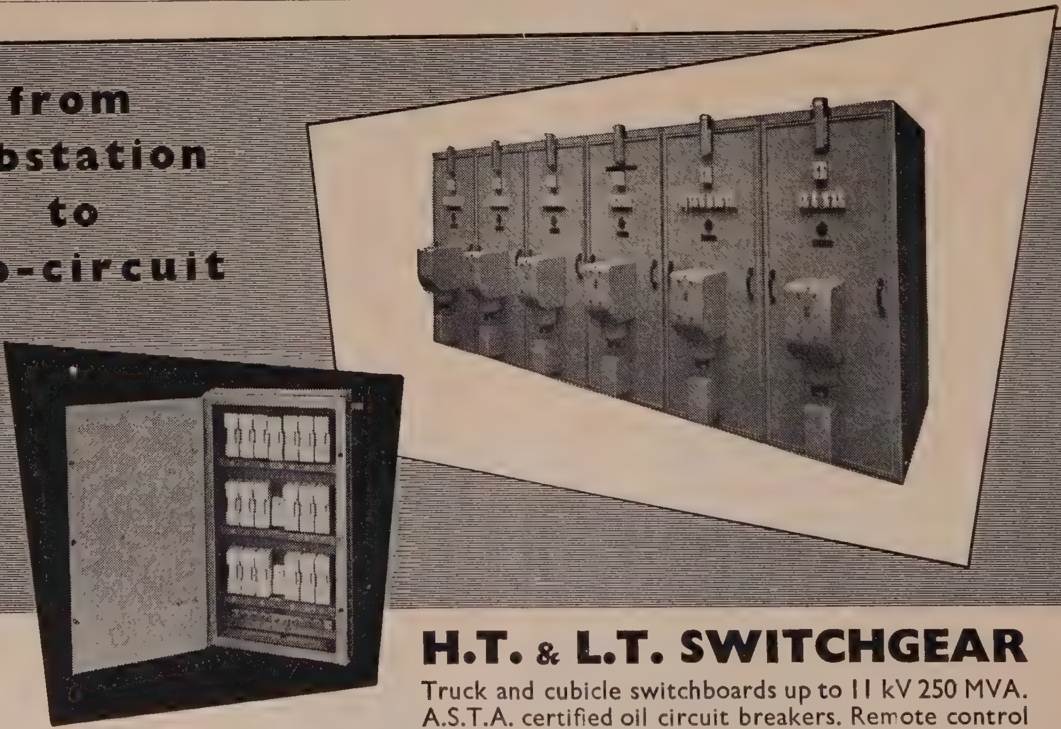
from
substation
to
sub-circuit



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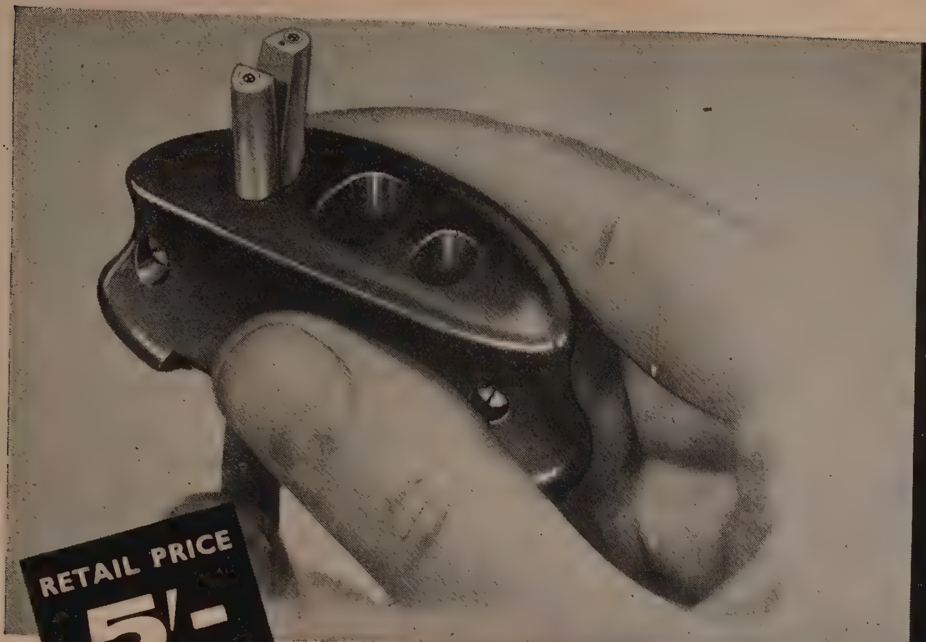

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3/.029 Twin Flat.
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This stripper will be of inestimable value to every electrical wiring contractor and is available from your wholesaler.

- **SPEEDS UP WIRING INSTALLATIONS**
- **SMALL, COMPACT AND EASY TO HANDLE**
- **CONVENIENTLY PRICED**

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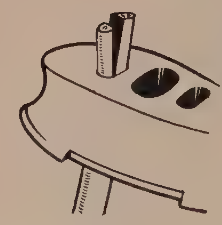
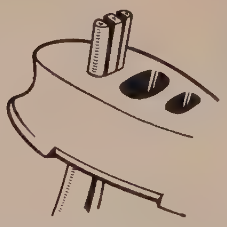


Insert Cable into the appropriate aperture and force the stripper along the Cable to the desired length.

2



For Twin with Earth Cable the process must be repeated for each conductor.

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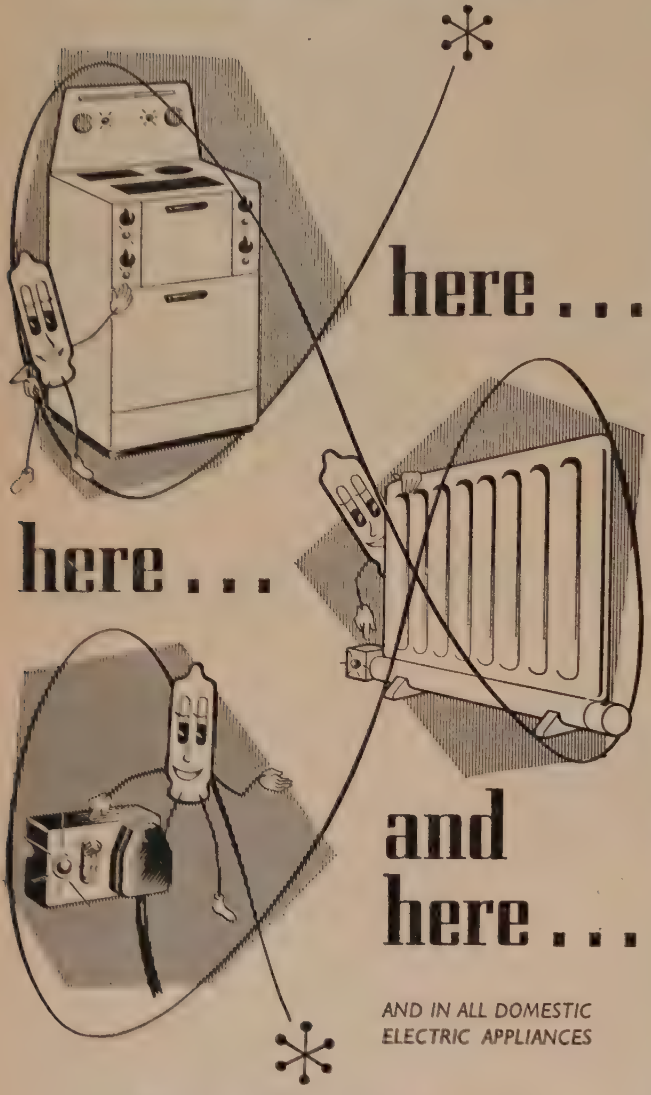

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here . . .

and
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N4

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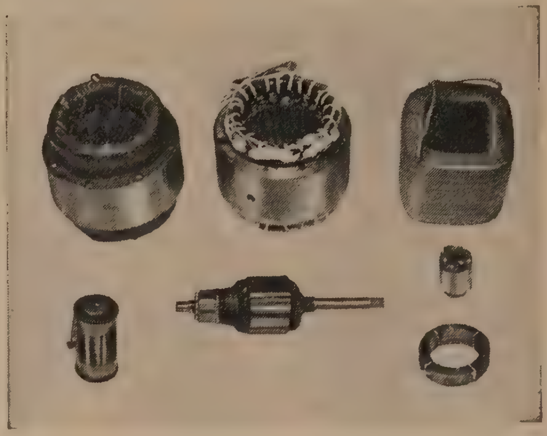

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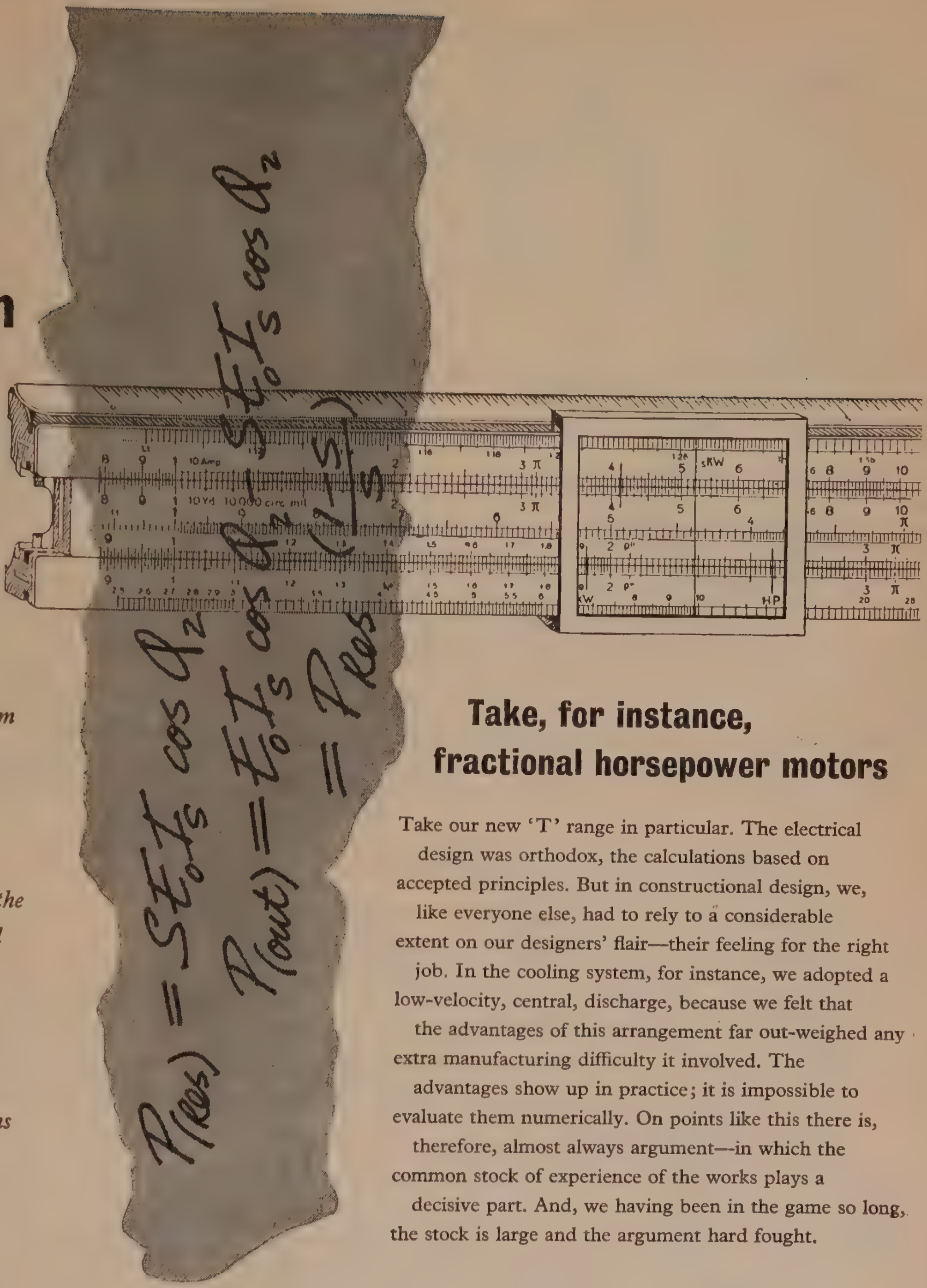
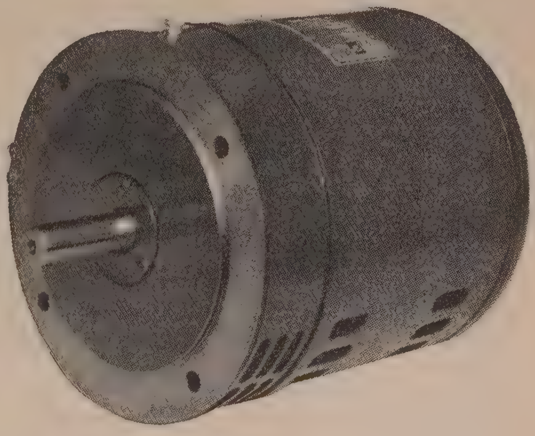

$P_{(res)} = SE_oI_s \cos \phi_2$
$P_{(out)} = E_oI_s \cos \phi_2 \; SE_oI_s \cos \phi_2$
$= P_{res} \frac{(1-S)}{S}$
10 Amp
10 Yd 10 000 circ mil
kW
HP

The first steps in design are usually mathematical; the determination say, of the optimum of active material required for a given performance. Here the designer depends on his knowledge of the most recent work on electromagnetic theory, the potentiality of new materials and new techniques. Every designer must keep abreast of such developments. But as the design proceeds he has to make decisions of a different kind. These decisions will depend on direct experience; on knowledge obtained in practice and too complex to be reduced to a set of equations. This plays a vital part in design.

Take, for instance, fractional horsepower motors

Take our new 'T' range in particular. The electrical design was orthodox, the calculations based on accepted principles. But in constructional design, we, like everyone else, had to rely to a considerable extent on our designers' flair—their feeling for the right job. In the cooling system, for instance, we adopted a low-velocity, central, discharge, because we felt that the advantages of this arrangement far out-weighed any extra manufacturing difficulty it involved. The advantages show up in practice; it is impossible to evaluate them numerically. On points like this there is, therefore, almost always argument—in which the common stock of experience of the works plays a decisive part. And, we having been in the game so long, the stock is large and the argument hard fought.



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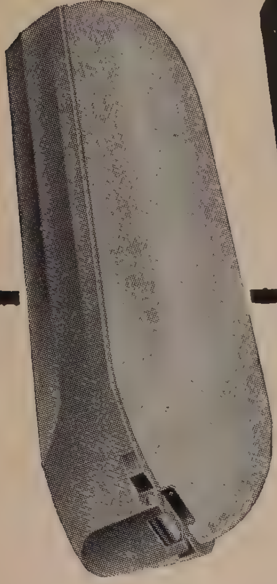
COMPLETE WITH TWO 12-inch, 8-watt LAMPS



Wherever a 25/40/60 watt tungsten filament lamp is now used here is a vastly superior fitting for all such applications.

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2. Fully tested before and after fitting lamps.
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5. Perspex cover, for maximum light transmission and diffusion.
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9. Shrouded lampholders to accommodate lamps to American, European or British standards of tube diameter.
10. Lamp life 12 months or more when operated continuously.

Please see leaflet L 300 for complete details.

Lampholder (Patent applied for). Design of Fitting (Registration applied for).

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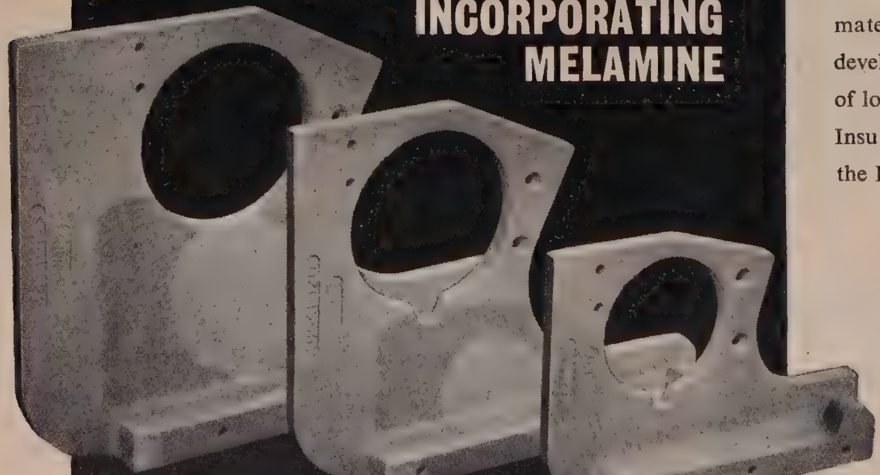

As Manufacturers of Electrical Insulating and Arc and Heat Resisting Materials, we have been privileged to supply the major requirements of Moulded Arc Shields to the Electrical Industry for many years.

'KRISMALEX' C.M.I./2, a Cold Moulded material incorporating Melamine is a new development, and as an Arc Resisting Material of low moisture absorption and good Electrical Insulating properties, is of special interest to the Industry. It is non-tracking.

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Illustration: Rolling mill type contactor Arc Shields by courtesy of Brookhirst Igranic Ltd.

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Manufacturers of Electrical Insulation
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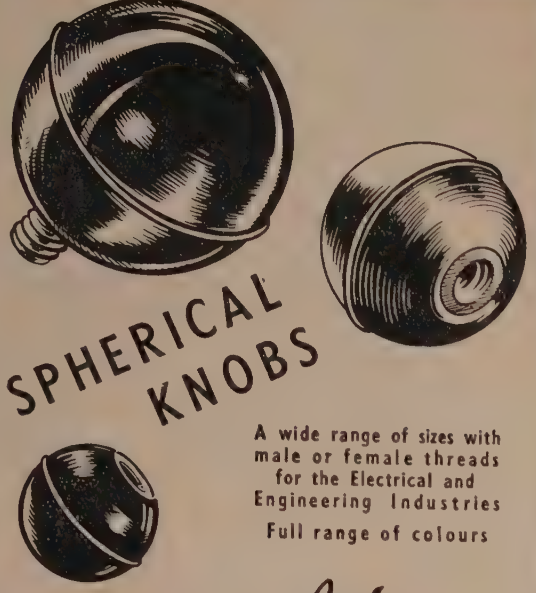

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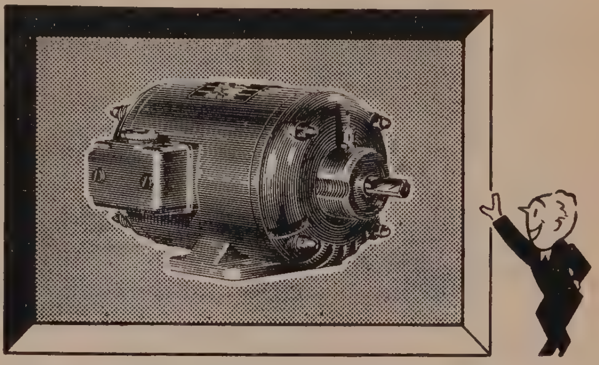

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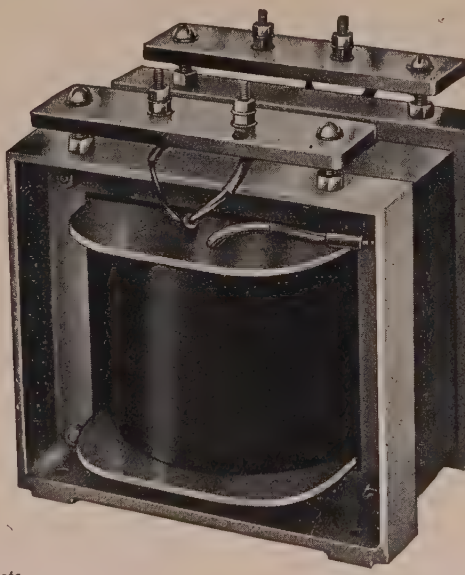

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350 V.A. to 2 K.V.A.

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Pioneers...

The earliest known ball-bearing device was made during the reign of Caligula (A.D. 12–41). This consisted of two large wooden discs, the upper of which revolved, on eight captively mounted bronze balls, around a central peg in the lower disc. This device is believed to have been the base of a rotating statue. At a later date Leonardo da Vinci (A.D. 1452–1519) was able to contribute much to man's knowledge of friction and designed a number of ingenious bearings; but it was not until the end of the eighteenth century that C. A. de Coulomb, a French scientist, developed a spherical bearing with any resemblance to the types in use today. The now indispensable ball-bearing thus took at least eighteen centuries to evolve.

In contrast, it is only twenty years since nylon was made available as an alternative fibre to silk, and it is only four years since the Crabtree Company pioneered its use in wiring accessories—as a bearing in the standard tumbler switch. The Company's leadership was once again endorsed by other manufacturers who rapidly came to appreciate the unrivalled qualities of nylon for the moving parts of electrical control equipment. It is this kind of initiative which has won for the Company the respect and esteem which it so widely enjoys.

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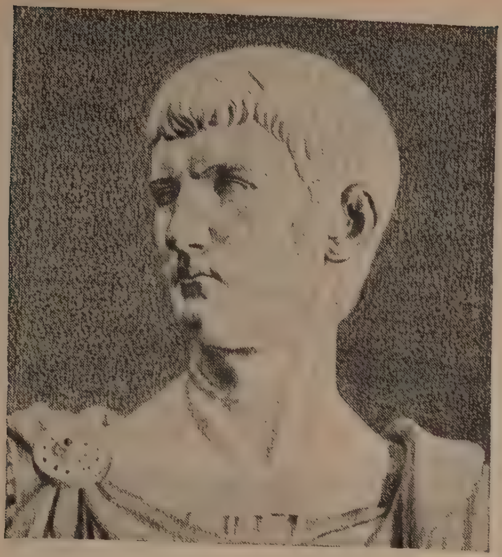
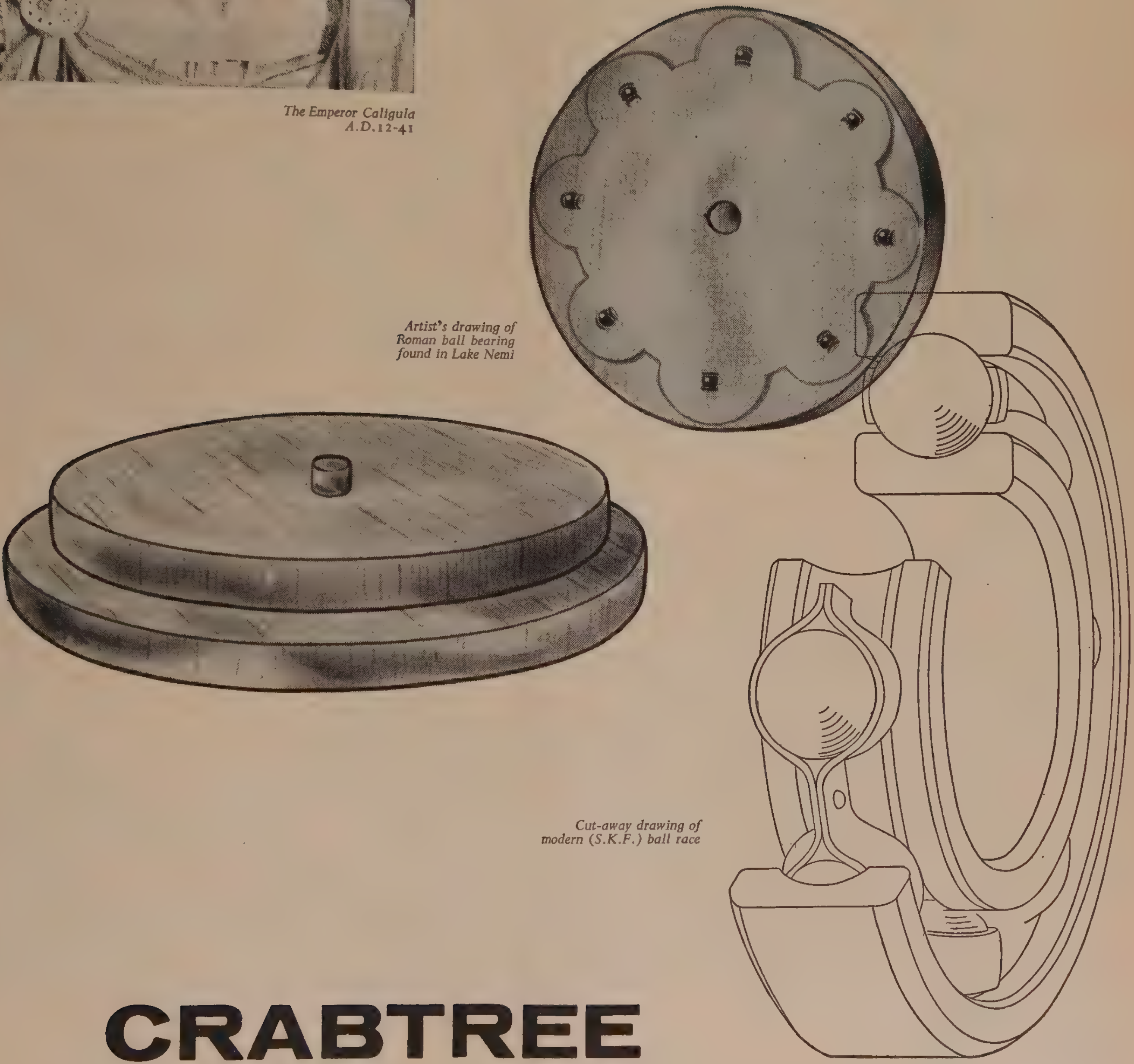
Manufacturers of



The Emperor Caligula
A.D.12-41



Artist's drawing of
Roman ball bearing
found in Lake Nemi

Cut-away drawing of
modern (S.K.F.) ball race

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Industrial Installations throughout the Country. Power, Maintenance and Insurance
CITY ELECTRICAL CO.
Emerald Street, W.C.1 *Telephone: HOL. 9722 (6 lines)*
Repairs and Rewinds—Motor Stockists

A. TINDALL & SONS
22 Rosemary Avenue, Enfield
Electrical Engineers and Contractors
Telephone: ENField 6612 (3 lines)

F. W. BLANSHARD LTD.
23 Lansdowne Road, Purley, Surrey
Telephone: Uplands 4818, 4819 & 4810
Complete electrical installations. Rewinding and repair of motors and transformers. Manufacturers of control gear for fluorescent.

SERVICE ELECTRIC CO. LTD.
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Electrical Installations of every kind. Motor Rewinds. Factory Maintenance

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Motor and generator repairs and rewinds. Installations and factory maintenance. Electrical plant stockists

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Electrical, Refrigeration and Radio Engineers. Installation Contractors. Lifts. Television
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Telephones 4820/1 (Day and Night)

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HOLLISTER'S (Electrical Contractors) LTD.

Gravesend	Gillingham	Ashford, Kent
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Heavy engineering and electrical contracting for farm, factory and estate
DRAKE & FLETCHER LTD.
Maidstone, Kent
Telephone: 2284 & 51996
Refrigeration. Repairs. Oil heating and drying installations

F. W. BLANSHARD LTD.
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Telephone: Uplands 4818, 4819 & 4810
Complete electrical installations. Rewinding and repair of motors and transformers. Manufacturers of control gear for fluorescent.

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. . . for all electrical installations
F. H. WHEELER & CO. LTD.
32 Brassey Road, Winton, Bournemouth
Telephone: Winton 1609

. . . for all electrical installations
F. H. WHEELER (Southern) LTD.
Clifton Hall, Oakley Road, Shirley, Southampton
Telephone 73867 & 76056

GOATER & MEDWAY LTD.
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Cable Jointing. Cable Laying. By Direct Contract and to the Trade.

SOUTH WESTERN

. . . for all electrical installations
F. H. WHEELER (Bristol) LTD.
55 Queen Charlotte Street, Bristol 1
Telephone 26907

CLARKE BROS. (Stroud) LTD.
Bath Road, Stroud
Telephone: Stroud 1132/3
Electrical Engineers and Contractors
Rewinds and Repairs. Industrial Installations

(Continued on page 76)

(Continued from page 75)

EASTERN

Norwich . . Cambridge . . . Gt. Yarmouth . . . Lowestoft . . . Ipswich
EASTERN & HOME COUNTIES ELECTRICAL CONTRACTORS
Specialists in Large Scale Electrical Installation Contracts.
Electra House, Southtown Road, Gt. Yarmouth
Telephone: Gt. Yarm. 2390

EAST MIDLANDS

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C. A. J. BILLINGTON LTD.
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Industrial Installation throughout the Home Counties

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WALKER BROS. (ELECTRICAL ENGINEERS) LTD.
Quality House, Temple Row, Birmingham 2
Telephone: CEN. 7611/5
Electrical Installation Engineers. Industrial Installation Specialists
Established 1895

HARRIS & SHELDON LTD.
31 Stafford Street, Birmingham 4
Telephone: Central 7101
For all electrical contracting installations, lighting, heating, power, public address, etc.

Electrical and Mechanical Engineers, Factors
THE BIRMINGHAM POWER TRANSMISSIONS LTD.
117/118 Snow Hill, Birmingham 4
Telephone: AST. 2088-9

. . . for all electrical installations
F. H. WHEELER & CO. LTD.
553 Moseley Road, Birmingham 12
Telephone: Calthorpe 2601-2

DYNAMO & MOTOR REPAIRS LTD.
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Motor and generator repairs and rewinds. Installations and factory maintenance.
Electrical plant stockists

ELECTRICAL INSTALLATIONS LTD.
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Telephone 22970
Industrial Electrical Work of All Kinds. Over 40 Years' Experience

SOUTH WALES

CLARKE BROS. (Stroud) LTD.
Green Park Street, Aberavon
Telephone: Port Talbot 791
Electrical Engineers and Contractors
Rewinds and Repairs. Industrial Installations

DRAKE & GORHAM (Contractors) LTD.
13 St. Andrew's Crescent, Cardiff
Telephone: Cardiff 32080
Electrical Engineers and Contractors

. . . for all electrical installations
F. H. WHEELER & CO. LTD.
117 Woodville Road, Cardiff
Telephone 21281-2 *Telegrams: " Whelect "*

CLARKE BROS. (Stroud) LTD.
High Street, Merthyr Tydfil
Telephone: Merthyr Tydfil 377
Electrical Engineers and Contractors
Rewinds and Repairs. Industrial Installations

MERSEYSIDE & N. WALES

Electrical Engineers and Contractors for over 50 years
TROUGHTON & YOUNG LTD.
46 Rodney Street, Liverpool 1
Telephone: Royal 9231

HIGGINS & CATTLE LTD.
322 India Buildings, Water Street, Liverpool 2
Telephone: Liverpool Central 1729
Electrical Engineers and Contractors

H. J. CASH & CO. LTD.
28 Chapel Street, Liverpool 3
Telephone: Central 0452
Electrical Engineers and Contractors

YORKSHIRE

Electrical Engineers and Contractors
SOUTHERN & REDFERN LTD.
Woodhead Road, Bradford 7
Textile Maintenance, Repairs and Rewinds
Telephones: Bradford 23871—Late Phone: Bradford 65837

EDMUNDSONS CONSTRUCTION CO. LTD.
Electrical Engineers and Contractors
2 Hartley Hill Leeds 2
Telephone: Leeds 33791

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F. H. WHEELER & CO. LTD.
44 Bank Street, Sheffield 1
Telephone 24015 (3 lines) *Telegrams: " Whelect "*

NORTH WESTERN

H. J. CASH & CO. LTD.
28 Chapel Street, Liverpool 3
Telephone: Central 0452
Electrical Engineers and Contractors

STEWART THOMSON & SONS (Liverpool) LTD.
Fort Road, Seaforth, Liverpool 21
Repairs and Rewinds A.C. and D.C. to 3,000 horsepower. Breakdowns, Urgent Repairs, etc. 24-hour service
Telephone: Bootle 2697-8

DRAKE & GORHAM (Contractors) LTD.
21 Newton Street, Piccadilly, Manchester 1
Telephone: Manchester Central 4701
Electrical Engineers and Contractors

. . . for all electrical installations
F. H. WHEELER & CO. LTD.
Regal Buildings, Oxford Road, Manchester 1
Telephone: Central 8207-8

Industrial Installations
W. H. SMITH & CO. ELECTRICAL ENGINEERS LTD.
12 York Street, Manchester 2
Telephone: CENtral 2991-6
Works: Praed Road, Trafford Park, Manchester 17

THE NELSON ENGINEERING CO. LTD.
Telephone: Nelson 62545
Electrical and Mechanical Engineers.
Complete Industrial Installations. Rewinds
Netherfield Road, Nelson

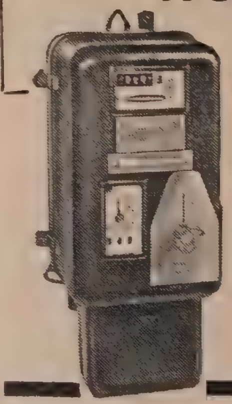
NORTH EASTERN

Engineers and Contractors
CITY ELECTRICAL CO.
Turks Head Yard, Cecil Street, Lincoln
Telephone: Lincoln 124 *London: HOLborn 9722*

. . . for all electrical installations
F. H. WHEELER & CO. LTD.
52 Elswick Road, Newcastle
Telephone: Newcastle 36271

Applications for particulars of costs and standard style of advertisements in this Regional Guide should be addressed to:

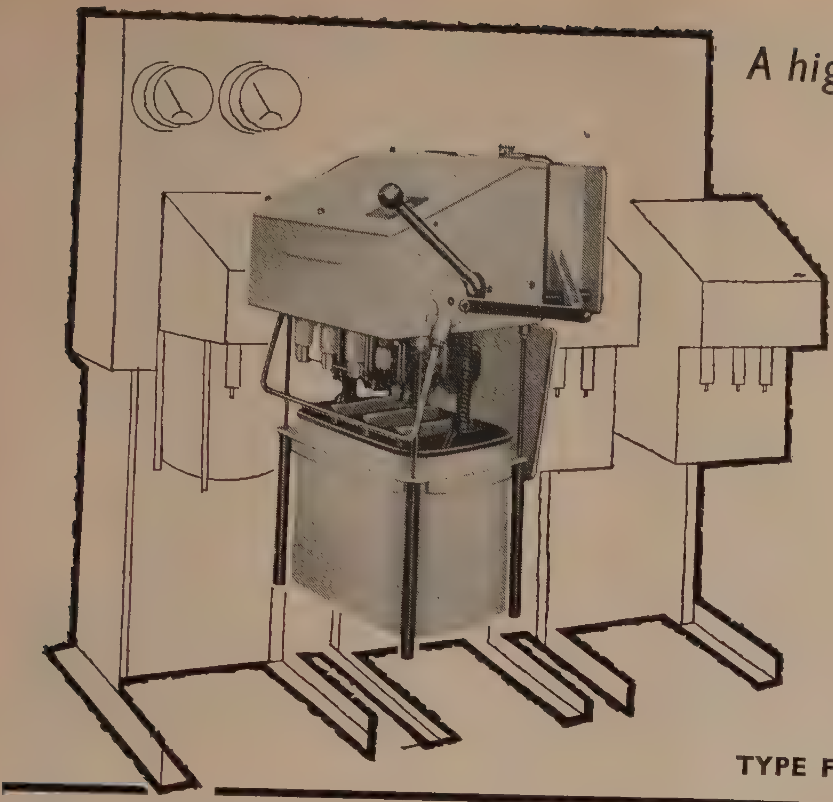
THE
ADVERTISEMENT DEPARTMENT,
ELECTRICAL REVIEW,
DORSET HOUSE, STAMFORD STREET,
LONDON, S.E.1



HOUSE SERVICE METERS

Credit Pattern
and Prepayment Type
200-240 v. A.C. S/Ph 50 c. (& D.C.)
AVAILABLE FROM STOCK
POLYPHASE 400-440 v. 3-wire Type
Ex Stock

UNIVERSAL ELECTRICAL CO.
217-221 City Road, London, E.C.1



A highly rated circuit breaker

OTTERMILL

TYPE FD4 Oil Circuit Breaker Units rated at 800, 1,000 and 1,200 amps. are an extension to the well established range of FD medium voltage switchgear

- Short Circuit tested to 25 MVA
- Voltages up to 660 volts
- Compact design with small unit centres
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Telegrams : Busbar Ottery St. Mary

For information on complete switchboards or switchboard mounting units please write or 'phone for details

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FUNCTIONS OF COMPLEX VARIABLES
By Philip Franklin.
This book is outstanding for its clear and precise explanation of a branch of mathematics which has often been obscured in a haze of highly abstract concepts. Logical and essentially complete, its purpose is to introduce the reader to the general properties of an analytical function of a single complex variable. 25/- net.

TRANSFORMERS
By F. C. Connelly, Ph.D., etc.
Here, gathered into one volume for the first time, is information about the different types of transformers required in line and radio communication, radio-frequency heating, electronics, portable machine tools, electro-medical equipment, illumination and measuring apparatus. 35/- net.

ALTERNATING CURRENT BRIDGE METHODS
For the Measurement of Inductance, Capacitance and Effective Resistance at Low and Telephonic Frequencies.
By B. Hague, D.Sc., etc. 5th Edition.
A theoretical and practical handbook for the use of advanced students. 60/- net.

FROM ALL BOOKSELLERS

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TECHNICAL BOOKS
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CONTACTS

for maintenance or production

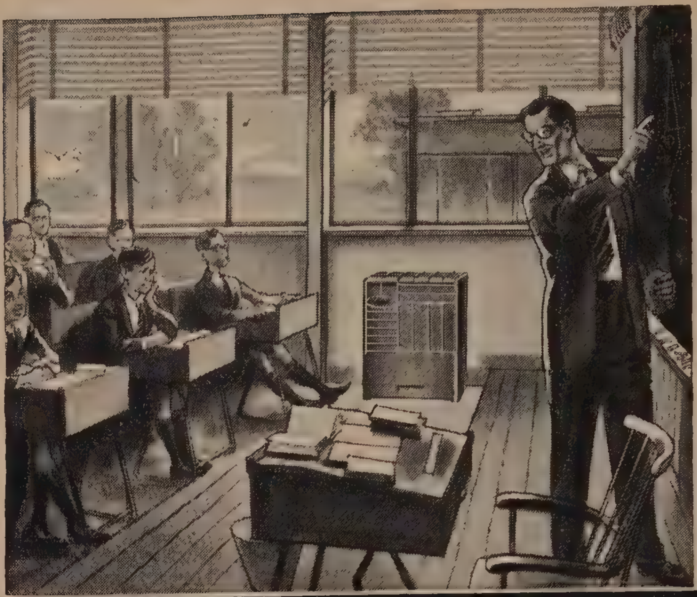
A DOZEN OR A MILLION

A.I.D. Approved

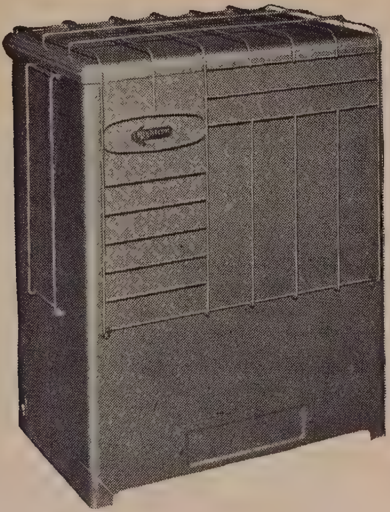
Contacts for every electrical purpose in any metal. Switch and Control Gear spares for every type of British or Foreign Gear. Any Quantity. We supply hundreds of maintenance electrical engineers and switchgear manufacturers throughout the world.

PAXTONS (ELECTRICAL) LTD.
WESTON – SUPER – MARE
Telephone: 1357

Use Off-Peak Tariffs and cut the cost of Heating with



Nightstor Heaters



CUT FUEL COSTS. Nightstor Heaters store heat by night—taking advantage of the cheaper off-peak tariffs available from all Electricity Boards—and dissipate heat by day. Separate thermostatic control ensures that the heaters use only the minimum current necessary to provide a comfortable temperature throughout the following day from first thing in the morning. Thus Nightstor Heaters are not only efficient and clean, but also represent maximum economy.

CUT CAPITAL COSTS. Simple and inexpensive to install, without alteration to structures or fittings. Nightstor Heaters are compact units which can be safely placed right up against the wall, using the minimum of floor space.

CUT MAINTENANCE COSTS. Controlled automatically, Nightstor Heaters once installed need no maintenance or attention.

Nightstor is a G.E.C. product
(Not available for domestic use)

The G.E.C. specialises in industrial heating and manufactures every type of appliance.
Make use of our free advisory service without obligation.

THE GENERAL ELECTRIC COMPANY LIMITED, MAGNET HOUSE, KINGSWAY, LONDON WC2

Classified Advertisements

CLASSIFIED advertisements are PREPAID at 3/6 per line (approx. 6 words) per insertion. Where an advertisement includes a Box Number there is an additional charge of 1/-.

DISPLAYED CLASSIFIED:—48/- per inch. Cheques and Postal Orders should be crossed and made payable to ELECTRICAL REVIEW PUBLICATIONS LTD.

SERIES DISCOUNTS for consecutive insertions:—13, 5%; 26, 10%; 52, 15%.

SITUATIONS WANTED:—Three insertions under this heading can be obtained for the price of two if ordered and prepaid with the first insertion.

REPLIES TO BOX NUMBERS should be addressed to the Box Number in the advertisement, c/o ELECTRICAL REVIEW, Dorset House, Stamford Street, London, S.E.1. If an applicant for a situation appearing under a Box Number does not wish his reply to be forwarded to a particular firm or individual instructions to this effect should be addressed to the Advertisement Supervisor, ELECTRICAL REVIEW. The name of an advertiser using a Box Number cannot be disclosed.

Advertisements are accepted up to **first post on Monday** of the week of issue

If displayed with boxed rules, name or symbol block by **Friday** prior to week of issue

All communications to be addressed to:
Classified Advertisement Department,
ELECTRICAL REVIEW
Dorset House, Stamford Street
London, S.E.1

Original testimonials should not be sent with applications for employment

OFFICIAL NOTICES, TENDERS, ETC.

BOROUGH OF HIGH WYCOMBE

Street Lighting

Wycombe-Amersham Road, A.404

TENDERS are invited for the following:—

(1) Supply and erection of steel lighting columns and installation of auxiliary equipment, lanterns, wiring, etc.

(2) Supply of lanterns, 250-watt mercury discharge lamps and sets of auxiliary equipment.

Specifications, bills of quantities and forms of tender may be obtained from the undersigned, and the drawings and conditions of contract may be inspected at the Borough Engineer's Office, Municipal Offices, High Wycombe.

Tenders in a sealed envelope which shall bear no name or mark indicating the sender, but endorsed:—

(1) "Tender, Section A, supply and erection of lighting columns";

(2) "Tender Section B, supply of lanterns and auxiliary equipment";

must be delivered to the undersigned not later than Wednesday, 17th February, 1960.

The Council do not bind themselves to accept the lowest or any tender.

J. A. PARKINSON,
Borough Engineer and Surveyor.
3041

BOROUGH OF THETFORD

Street Lighting

TENDERS are invited for the supply and/or installation of 21 Concrete Street Lighting Columns (25 ft. mounting height) with Sodium Discharge Lamps, lanterns and all auxiliary equipment to Group A standard for street lighting of the Trunk Road A.11 at Thetford. Separate tenders are also invited for the supply and laying of the necessary street lighting cable.

The specification, bill of quantities and forms of tender may be obtained from the Borough Engineer, Municipal Offices, Thetford, Norfolk, on payment of two guineas, which will be refunded upon receipt of a bona fide tender and return of all documents.

Plans and general conditions of contract may be inspected at the Municipal Offices, Thetford.

Tenders, in plain sealed envelopes, endorsed "Street Lighting, Trunk Road A.11," must be delivered to the undersigned not later than noon on Monday, 15th February, 1960.

W. ELLIS CLARKE,
Municipal Offices, Town Clerk.
Thetford, Norfolk.
15th January, 1960. 3047

DURHAM COUNTY COUNCIL

TENDERS invited:—

Egglescliffe New Modern School: Electrical Installation.

Peterlee Dene House New Modern School: Electrical Installation.

Application for further details to County Architect, South Street, Durham, not later than 3rd February, 1960.

J. K. HOPE,
Clerk of the County Council.
Shire Hall,
Durham. 3045

NOTTINGHAMSHIRE COUNTY COUNCIL

Highways Committee

Street Lighting

TENDERS are invited for the supply and erection of Street Lamp Columns including lanterns and switchgear on the traffic island at the south end of the Doncaster By-pass, and sited at the north of Blyth cut, on the Nottingham-Bawtry Road A.614.

General conditions of contract, specification and bill of quantities are obtainable from the County Surveyor, Shire Hall, Nottingham, on payment of a deposit of £2, which will be returned on receipt of a bona fide tender not subsequently withdrawn, and the return of the documents.

The contract drawings may be inspected at the office of the County Surveyor during normal office hours.

Tenders should be returned, in the official envelope provided, to the undersigned by 4th March, 1960.

The Council does not bind itself to accept the lowest or any tender.

A. R. DAVIS,
Clerk of the County Council.
County Hall,
West Bridgford,
Nottingham. 3039

BOROUGH OF WIDNES

THE Corporation invites tenders for the supply of the undermentioned materials required in the Highways Department during the twelve months ending 31st March, 1961:—

1. Electrical Equipment.
2. Electric Lamps.
3. Gas Fittings and Mantles.

Forms of tender, specification and envelopes, in which the tenders must be submitted, may be obtained from F. A. J. Knight, Esq., A.M.I.C.E., M.I.Mun.E., Borough Engineer and Surveyor, Town Hall, Widnes.

Tenders, in envelopes provided, to be forwarded to reach the undersigned not later than 9 a.m. on Thursday, 11th February, 1960.

The Council do not bind themselves to accept the lowest or any tender.

FRANK HOWARTH,
Town Hall, Widnes. Town Clerk.
January, 1960. 2930

BOROUGH OF ALTRINCHAM

TENDERS are invited for the installation of 158 Lighting Units within the Borough. The contract includes the supply, erection and putting into service of 60-watt Sodium Lamps, lanterns and gear on 20-ft. concrete columns.

Specifications, schedules of prices and forms of tender may be obtained from, and plans inspected at, the office of the Borough Surveyor, Town Hall, Altrincham, upon payment of a deposit of £3 made payable to the Borough Treasurer.

The deposit will be returned on receipt of a bona fide tender not subsequently withdrawn and the return of all documents to the Council.

Tenders in the envelope provided must be returned to the Town Clerk, Town Hall, Altrincham, not later than 12 noon on 5th February, 1960.

The Council does not bind itself to accept the lowest or any tender.

E. GRAHAM THOMAS,
Town Hall, Town Clerk.
Altrincham. 3046

OLD FLETTON URBAN DISTRICT COUNCIL

Street Lighting Improvements

TENDERS are invited, on a fixed price basis, for improvement of street lighting to Group B standard of certain streets in the Urban District involving 44 lighting points.

Form of tender, conditions, specification and bills of quantities may be obtained from the Surveyor, Council Offices, Old Fletton, Peterborough.

Tenders, in plain sealed envelopes endorsed "Street Lighting Tender," must be delivered to the undersigned not later than 12th February, 1960.

The Council do not bind themselves to accept the lowest or any tender.

F. GREENWOOD,
Council Offices, Clerk of the Council.
High Street,
Old Fletton, Peterborough. 3008

BOROUGH OF HORNSEY

THE Council invites tenders for the supply of Fluorescent Fittings in connection with proposed lighting improvements to various schools.

Particulars can be obtained from the Borough Engineer and Surveyor, Town Hall, London, N.8.

Tenders are to be received not later than noon on the 8th February, 1960.

W. B. MURGATROYD,
Town Clerk.
3009

BOROUGH OF HORNSEY

Annual Supply of Sodium Discharge Lamps

TENDERS are invited for the supply of the above for the period ending 31st March, 1961. Documents on application to Borough Engineer, Town Hall, London, N.8.

Last date for receipt of tenders, Monday, 8th February, 1960.

W. B. MURGATROYD,
Town Clerk.
3040

SITUATIONS VACANT

(See "Replies to Box Numbers" above)

LEADING ELECTRICAL ENGINEERS AND CONTRACTORS

have the following vacancies in their Head Office, situated in West London:—

(a) SUPERVISING ENGINEERS with experience of estimating, designing and supervising all types of electrical installations. Experience with consultants an advantage. H.N.C. or equivalent preferred.

(b) ASSISTANT ENGINEERS to work with supervising engineers. Applicants should have served an apprenticeship in electrical contracting and should have O.N.C. or equivalent. Drawing office experience an advantage.

These posts offer excellent prospects in an expanding company. Staff pension and bonus schemes in operation.

Write stating age, experience and qualifications to—Box 2995.

Situations Vacant *(continued)*

SOUTH OF SCOTLAND ELECTRICITY BOARD

Glasgow Area

APPLICATIONS are invited to fill the undernoted vacancies :—

SECOND ASSISTANT DISTRICT
ENGINEERS (2 vacancies)
(Ref. No. T/60/1).

THIRD ASSISTANT DISTRICT
ENGINEER (Eastern District)
(Ref. No. T/60/2).

Applicants should have a sound engineering training with subsequent experience in the operation and maintenance of large distribution systems at voltages up to and including 33 kV. Experience in the planning and preparation of schemes for new development and network reinforcement would be an advantage.

The possession of qualifications leading to Graduate Membership of the Institution of Electrical Engineers is desirable.

Salary scales: One Second Assistant (Western District), Class F, Grade 7, £910/£955 p.a.; one Second Assistant (Central District), Class H, Grade 7, £1,025/£1,085 p.a.; one Third Assistant, Class G, Grade 9, £860/£905 p.a.

GENERAL ASSISTANT DISTRICT
ENGINEERS (5 vacancies),
Western, Eastern, Southern
and Central Districts
(Ref. No. T/60/3).

The minimum qualification for the positions will be the Ordinary National Certificate for Electrical Engineering and applicants should have some experience of E.H.V. and L.V. distribution systems and substation equipment.

Salary scales: Class F, Grade 11, £710/£755 per annum; Class G, Grade 11, £765/£810 per annum; Class H, Grade 11, £815/£860 per annum.

FOURTH ASSISTANT ENGINEER
(Planning and Development)
(Ref. No. T/60/4).

Applicants should have a sound engineering training with subsequent experience in the design and layout of large distribution systems at voltages up to and including 33 kV in a densely loaded area. A knowledge of the application of modern protective equipment and of the calculation of fault levels and preparation of load flow diagrams would be an advantage.

The possession of qualifications leading to Graduate Membership of the Institution of Electrical Engineers is desirable.

Salary scale: Class L, Grade 13, £860/£905 per annum.

The above appointments will be superannuable. The conditions of employment will be in accordance with the National Joint Board Agreement for the Electricity Supply Industry and the successful candidates will require to reside within reasonable distance of the appropriate District or Area Headquarters.

Applications, quoting the relevant reference number, should be made on the standard form AE6, which may be obtained from the undersigned and should be completed and returned within 14 days of the appearance of this notice.

A. KELSO,
Manager.

P.O. Box 6,
75, Waterloo Street,
Glasgow, C.2.

3007

JOSEPH LUCAS (ELECTRICAL) LIMITED

TECHNICAL ASSISTANT

in possession of O.N.C. (Electrical) required to assist in development of automobile generators and starter motors. The position provides a first-class opportunity to gain experience in development of products for quantity manufacture using the most modern techniques, and there are excellent prospects for promotion. Suitable candidates will be allowed day release to obtain H.N.C. Applicants should have previous development experience in light electrical equipment, preferably with rotating machines. Progressive salary. Five-day week. Staff pension fund.

Apply in writing, stating age, qualifications and experience to the Personnel Manager, JOSEPH LUCAS (ELECTRICAL) LIMITED, Great King Street, Birmingham, 19, quoting ref. PM/D/366.

2993

POWER IN TRUST

CENTRAL ELECTRICITY GENERATING BOARD

DESIGN AND CONSTRUCTION DEPARTMENT

THIRD ASSISTANT ENGINEER (MECHANICAL)

required in the

PRODUCTION INSPECTION & TEST SECTION

at the Birmingham Regional Office

This section is concerned with the production, inspection and test in manufacturers' works of mechanical and electrical plant and equipment required for generation (including nuclear) and transmission purposes.

Candidates should preferably have qualifications equivalent to Graduate Membership of the Institution of Mechanical Engineers. Recent experience of production, inspection and test of mechanical or electrical plant in manufacturers' works is essential.

SALARY WITHIN THE SCALE £1,090 - £1,300 p.a.

Applications, stating age, qualifications, experience, present position and salary, to the Personnel Officer, 24/30, Holborn, London, E.C.1, by 5th February, 1960. Envelopes should be marked "Confidential Ref. ER/16."

3048

SOUTH WESTERN ELECTRICITY BOARD

APPLICATIONS are invited for the following positions:—

FOURTH ASSISTANT ENGINEER,
BRISTOL GROUP.

Salary according to Class L, Grade 13, £860 × £15 to £905 per annum of the N.J.B. Agreement.

The successful candidate will be required to assist generally in the technical work of the Group Engineering Department, including system planning and design; load forecasts; technical reports and calculations; system operation and construction progressing.

Applicants should have had experience of the construction and operation of distribution systems up to 33 kV. Possession of qualifications at least equivalent to the Higher National Certificate in Electrical Engineering is desirable.

ENGINEERING DRAUGHTSMAN,
BRISTOL GROUP.

Salary within Grade 6, £620 × £20 to £740 per annum of Schedule D of the N.J.B. Agreement.

The successful candidate will be required to undertake ordnance and overhead line survey duties using standard surveying instruments. He should also be capable, under supervision, of estimating and preparing drawings associated with overhead line schemes.

Possession of a current driving licence and qualifications leading to the Higher National Certificate in Electrical Engineering are desirable.

Applications for the above posts to be made on standard form AE6/ACT OBTAINABLE BY POSTCARD ONLY from the Group Administrative Officer, South Western Electricity Board, Electricity House, Colston Avenue, Bristol, 1. Closing date for receipt of completed applications is 6th February, 1960.

3074

CENTRAL ELECTRICITY GENERATING BOARD

South Eastern Division
(Vacancy No. 15/60)

FOURTH ASSISTANT ENGINEER, Technical Department, Measurements Section, based at Croydon Power Station.

Duties cover maintenance of power station and bulk supply metering and instrumentation including instrument transformer testing and some site work. Experience in a Class A polyphase or similar type of testing station and possession of the H.N.C. would be an advantage. Salary within the range £775 to £985 per annum including London allowance.

Applications giving age and all relevant details, to Mr. G. H. D. Keen, Measurements Section, Croydon B Power Station, Beddington Farm Road, Croydon, Surrey. Closing date 1st February.

3076

CENTRAL ELECTRICITY GENERATING BOARD

Midlands Division

SHIFT CHARGE ENGINEER is required at Worcester Power Station. N.J.B. service conditions, superannuable appointment, salary within Schedule A, Grade E.7, £860-£905 per annum, plus shift allowance.

Applicants should have a sound technical training and practical experience in the operation and maintenance of steam generating plant and main switchgear. Appropriate qualifications desirable. Applicants who applied for this position when advertised in November will be considered and need not re-apply.

Apply quoting vacancy number 10/60MD, on Form AE6, to the Establishments Officer, 53, Wake Green Road, Moseley, Birmingham, 13, by 1st February, 1960.

3050

RAILWAY ELECTRIFICATION

ASSISTANT FOREMAN REQUIRED

temporarily based at Chadwell Heath, Essex,
for ultimate employment at Romford or Pitsea.

Applicants should have served a recognised apprenticeship and be experienced in the installation, repair and maintenance of substations, supervisory control equipment, E.H.T. and L.T. cables. Should have knowledge of isolation and isolation procedure. Technical qualifications desirable.

Rate of pay for 44-hour week is £670 p.a. rising to £709 after two years. Enhanced pay for overtime and Sunday duty. Certain free and reduced rate rail travel facilities. Pension and sick pay schemes.

Successful applicant must pass medical examination.

Apply in writing to :—

Electric Traction Engineer (London Area)
British Railways, Eastern Region
off Ley Street, Ilford, Essex

3052

ROYAL NAVAL SCIENTIFIC SERVICE

SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS required in following localities :—

LONDON AREA: MECHANICAL ENGINEER with sound knowledge of basic principles of thermo and fluid dynamics to carry out research programme in particular field of applied hydrodynamics. Experience in modern methods of design and research on axial flow compressors, turbines or pumps an advantage. MECHANICAL ENGINEER for research on precision gear design. MECHANICAL ENGINEER for work on propulsion problems. APPLIED MATHEMATICIAN for research of basic nature on stability of underwater vehicles; knowledge of theoretical hydrodynamics and theory of control mechanisms an advantage. APPLIED MATHEMATICIAN or THEORETICAL PHYSICIST for acoustic analysis. APPLIED MATHEMATICIAN for work with electronic computers, with special reference to research into general underwater physical problems. ELECTRONIC PHYSICISTS for data handling and analysis problems. EXPERIMENTAL PHYSICIST for research in underwater acoustics. PHYSICIST interested in operation performance. CLASSICAL PHYSICISTS.

BALDOCK: PHYSICISTS or APPLIED MATHEMATICIANS for research in Metal or Quantum Physics.

PORTSMOUTH: PHYSICISTS with experience in field of microwave techniques. ELECTRONIC/ELECTRO-MECHANICAL ENGINEERS (experience in servo-mechanisms an advantage).

HASLEMERE: ELECTRONIC ENGINEER.

PORTLAND: PHYSICISTS or APPLIED MATHEMATICIANS for research in underwater acoustics. PHYSICISTS (general). ELECTRICAL ENGINEERS with advanced electronic design experience. MECHANICAL ENGINEERS. PHYSICAL CHEMISTS.

POOLE: CHEMICAL ENGINEERS. CHEMISTS with experience in rubber technology.

ROSYTH: MECHANICAL ENGINEER with experience in welding development. ELECTRONIC PHYSICISTS.

Candidates must normally be natural-born British subjects of natural-born British parents, with First or Second Class Hons. Degrees or equivalent qualifications. S.S.O.s must have had three years' postgraduate experience and be not less than 26 years of age.

Salaries (men): S.S.O. £1,233-£1,460; S.O. £655-£1,150 (London); somewhat lower in Provinces. Appointments unestablished (with F.S.S.U. benefits), but opportunities may occur for those under 32 to compete for established posts.

Forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1 (quote A.483/9A). 259

FEDERAL POWER BOARD OF RHODESIA AND NYASALAND

Linesmen

APPLICATIONS are invited from linesmen experienced in the maintenance of high-voltage equipment for three appointments in the Board's transmission system organisation.

The salary is £1,200 per annum, and housing with hard furniture will be provided at a reasonable rental. The successful applicants will be required to contribute to the Board's pension fund. Two of the appointments are at Sherwood Depot (near Que Que) and the third is at Kariba. The linesmen serving at Sherwood will be provided with housing at Que Que, and transport will be provided to take them to work. The linesman at Kariba will be paid a non-pensionable allowance of £10 per month.

Applications giving full details of age, experience, qualifications and marital status should be posted so as to reach the Secretary, Federal Power Board, Reliance House, P.O. Box 630, Salisbury, Southern Rhodesia, not later than 15th February, 1960. 3058

Senior Transformer Designer

required by

a well-established company in the South of England. Applicant should have degree or H.N.C. and preferably some years' experience with transformers up to 20,000 kVA and 66 kV, with on-load tap changing gear.

The post carries a progressive salary combined with excellent conditions of employment, including superannuation.

Written application giving full details of age, nationality, qualifications, experience and salary required to—Box 3063.

FEDERAL POWER BOARD OF RHODESIA AND NYASALAND

System Operation Department

APPOINTMENT of:—
(1) SENIOR CONTROL CENTRE ENGINEER (1 vacancy).
(2) CONTROL CENTRE ENGINEERS (5 vacancies).
(3) ASSISTANT CONTROL CENTRE ENGINEERS (5 vacancies).

Applications are invited for the above appointments at the Board's System Control Centre being built at Sherwood, about 120 miles south-west of Salisbury. The interconnected system to be controlled will initially consist of a 900 mile 330 kV transmission system linking certain existing power stations with the Kariba Hydro-Electric Scheme (initial capacity 600 MW, ultimate capacity at least 1,500 MW).

Applicants for (1) should be chartered electrical engineers and have had considerable experience in the operation of a large interconnected high-voltage system. Experience in power station operation and general administration would be an advantage. The successful candidate will work normal office hours and will be responsible to the System Operation Engineer for the operation of the System Control Centre. Salary £2,250 per annum.

Applicants for (2) should have had experience in the operation of an interconnected high-voltage system and preferably experience in power station operation. Qualifications leading to associate membership of a recognised engineering institution are desirable. The successful candidate will be responsible for the operation of the Board's interconnected system, including switching, load despatching and associated duties. Salary £1,700 per annum, plus 10% shift allowance.

Applicants for (3) should possess adequate general and technical qualifications and preferably have had experience in high-voltage system or power station operation. Salary £1,400 per annum, plus 10% shift allowance.

All successful applicants will be required to contribute to the Board's Pension Fund. Housing and hard furniture will be provided by the Board at a reasonable rental in the town of Que Que (where there is the full range of Federal Government Schools) about 16 miles from Sherwood. Transport between Sherwood and Que Que will be provided.

The reasonable travelling and removal expenses of successful candidates and their families to Que Que will be paid by the Board.

Applications giving full details of education, training, experience, age and marital status should be posted so as to reach the Secretary, Federal Power Board, Reliance House, P.O. Box 630, Salisbury, Southern Rhodesia, not later than 5th March, 1960. 3059

COUNTY COUNCIL OF THE WEST RIDING OF YORKSHIRE

Office of the County Architect

APPLICATIONS are invited for the under-mentioned posts :—

Central Office, Wakefield

JUNIOR ELECTRICAL ENGINEERING ASSISTANT.
Grade A.P.T. II, £765-£880.

Candidates should hold the Higher National Certificate in Electrical Engineering and be capable of preparing schemes, specifications and estimates.

Huddersfield Divisional Office

ELECTRICAL ENGINEERING INSPECTOR.
Grade A.P.T. I, £610-£765.

Candidates should hold the Ordinary National Certificate in Electrical Engineering and have had practical experience in inspecting, supervising and testing electric lighting and power installations, and be able to prepare specifications and drawings for simple maintenance schemes.

Applications to be submitted by the first post on Tuesday, 2nd February, 1960, on forms to be obtained from and returned to the undersigned.

A. W. GLOVER, F.R.I.B.A.
County Architect.

Bishopgarth,
Westfield Road, Wakefield. 3027

***Situations Vacant** (continued)*

YORKSHIRE ELECTRICITY BOARD

Head Office

TRAINEE SHIFT CONTROL ENGINEER

The successful applicant, who should have had operational experience and should hold the Higher National Certificate or its equivalent, will undergo a course of training in one of the Board's five Regional Control Centres, and expenses will be paid during the training period.

Salary during training: N.J.B. Scale AX-EX, Grade 6 (plus 10% shift enhancement), £1,017 10s./£27 10s./£1,155 rising to £1,287 per annum; and on taking over responsibilities for a shift: N.J.B. Scale AX-EX, Grade 5 (plus 10% shift enhancement), £1,199/£27 10s./£1,336 10s. rising to £1,490 10s. per annum.

Applications, giving full details of age, qualifications and experience, together with the names of two referees, should be forwarded to the Secretary, Head Office, Yorkshire Electricity Board, Wetherby Road, Scarcroft, Nr. Leeds, not later than 5th February, 1960.

No. 3 (Sheffield) Sub-Area

FOURTH ASSISTANT ENGINEER
(Operation and Maintenance).

Applicants should have had experience on high voltage electrical distribution systems, and should be technically qualified up to Higher National Certificate standard.

Salary N.J.B. Class M, Grade 13, £910/£15/£955 per annum.

Applications, giving full details of age, qualifications and experience, together with the names of two referees, should be forwarded to the Manager, No. 3 (Sheffield) Sub-Area, Yorkshire Electricity Board, Commercial Street, Sheffield, not later than 5th February, 1960.

No. 1 (Bradford) Sub-Area

BRADFORD DISTRICT
ASSISTANT CONSUMERS' ENGINEER.

Candidates should hold the Higher National Certificate in Electrical Engineering or an equivalent technical qualification. They should be capable of preparing specifications in respect of lighting, heating and power installations and of dealing with consumers' queries regarding the application of electricity for domestic, commercial and industrial purposes.

Salary N.J.B. Class J, Grade 12, £815/£15/£860 per annum.

Applications, giving full details of age, qualifications and experience, together with the names of two referees, should be forwarded to the Manager, No. 1 (Bradford) Sub-Area, Yorkshire Electricity Board, 45-53, Sunbridge Road, Bradford, not later than 5th February, 1960.

3061

COMPUTER CONTROLLED PROFILING MACHINES

Installation and Maintenance

TWO ENGINEERS

are required for work on the installlation and subsequent servicing of tape controlled automatic profiling machines. Candidates should have the H.N.C. or equivalent qualification in electrical engineering and have experience of electro-mechanical and electronic devices and control systems. Experience of servicing light current electrical installations may be an advantage.

A period of training will be given prior to the machine installations, and for the first twelve months thereafter, one engineer will be resident on the N.E. coast and one in the N.W. Lancashire area.

Applicants who should be at least 30 years of age, will be offered a good commencing salary and they should be earning not less than £1,000 per annum in their present employment. A contributory pension scheme is in operation.

Please reply stating full particulars to the:

Personnel Manager
BRITISH OXYGEN GASES LTD.
Spencer House, St. James's Place,
London, S.W.1

3044

RECTIFIER & SWITCHGEAR TEST ENGINEERS

APPLICATIONS are invited from suitably qualified engineers for appointments dealing with the following products :—

RECTIFIER DIVISION

Mercury arc and semi-conductor rectifiers.
Variable speed drives—grid controlled and transductor controlled.
Rectifier transformers.

SWITCHGEAR DIVISION

Distribution switchboards.
Motor starter units and switchboards.
Control boards.

These appointments provide excellent opportunities for young engineers to become conversant with a wide range of equipment and for promotion within the organisation.

Good working conditions. Canteen facilities, etc.

All applications in strictest confidence, quoting ref. TJR, to :—

LANCASHIRE DYNAMO NEVELIN LTD.
Hurst Green, Oxted, Surrey

2983

CENTRAL ELECTRICITY GENERATING BOARD

Southern Project Group

Hinckley Point Nuclear Generating Station

Second Assistant Engineer (Instrumentation)

APPLICATIONS are invited for the position of SECOND ASSISTANT ENGINEER (INSTRUMENTATION) at Hinckley Point Generating Station now under construction.

The site is on the coast, approximately 10 miles north-west of Bridgwater, Somerset.

The successful applicant will be required to assist the Site Electrical Engineer in the supervision and commissioning of instrumentation in connection with both conventional and nuclear plant.

Applicants should have some works experience or apprenticeship training and previous experience on installation and commissioning of instruments and control equipment is essential. Experience in the nuclear instrumentation field is not essential, but would be an advantage.

Applicants should have qualifications up to Higher National Certificate and should preferably be Corporate Members of the Institution of Electrical Engineers.

This is a permanent appointment, and the successful candidate will be expected to live in the vicinity of the site for the duration of the construction work, which will be approximately three years. Opportunities will be available for transfer to future generating station sites and to the design teams associated with these stations.

The salary for the appointment will be within Grade 4 of Schedule C of the N.J.B. Agreement, i.e. £1,195-£1,545 per annum, according to qualifications and experience.

Applications stating age, qualifications, experience, present position and salary should be forwarded to the Administrative Officer, Central Electricity Generating Board, Southern Project Group, Squires Lane, Finchley, London, N.3, to arrive not later than Monday, 1st February, 1960.

Envelopes should be marked "Confidential, S/60/6."

3077

ADMINISTRATIVE COUNTY OF LEICESTER

ASSISTANT ELECTRICAL ENGINEER, £780 to £1,070 according to qualifications. Candidates should be in possession of the Higher National Certificate in Electrical Engineering and be capable of preparing schemes for electrical installations in all types of buildings.

Lodging allowance and removal expenses may be paid to married men.

Apply by 5th February, 1960, on forms obtainable from County Architect, 123, London Road, Leicester.

3043

MIDLANDS ELECTRICITY BOARD

APPLICATIONS are invited for the following superannuable posts :—

North Staffs. Sub-Area

GENERAL ASSISTANT
DISTRICT ENGINEER (Leek).

Applicants should have had experience in the operation and maintenance of distribution systems. Technical qualifications desirable. Salary £655/£700 per annum (N.J.B. Grade F.12).

Apply by letter, stating age, education, experience, qualifications, present position and salary to Mr. C. C. Pimble, Sub-Area Manager, Midlands Electricity Board, 234, Victoria Road, Fenton, Stoke-on-Trent.

Shropshire & Herefordshire Sub-Area

GENERAL ASSISTANT
DISTRICT ENGINEER (Hereford).

Applicants will be required to assist generally in the construction, maintenance and operation of H.V. and L.V. mains. Technical qualifications desirable. Salary £710/£755 per annum (N.J.B. Grade F.11).

Apply by letter, within 14 days, stating age, experience, present position and salary to Mr. W. Winwood, Sub-Area Manager, Midlands Electricity Board, Spring Gardens, Ditherington, Shrewsbury.

Wolverhampton & District Sub-Area

GENERAL ASSISTANT
DISTRICT COMMERCIAL
ENGINEER (Walsall).

Duties will include estimating for contracting work and advising consumers in the use of commercial electrical equipment. A sound knowledge of electrical installation practice is essential. Salary £765/£810 per annum (N.J.B. Class G, Grade 11).

Apply by letter, within 14 days, stating age, qualifications, experience and present salary to Mr. D. Holt, Sub-Area Manager, Midlands Electricity Board, 83, Darlington Street, Wolverhampton.

F. W. CATER,
Secretary.

3022

METROPOLITAN BOROUGH OF FULHAM

Borough Engineer and Surveyor's Department

ELECTRICAL ENGINEERING ASSISTANT. N.J.C. special scale, £785/£1,070, plus £30 per annum London weighting, commencing according to qualifications and experience. Experience in the design and installation of street lighting essential and good general experience of electrical installations is also required. Membership of I.E.E., A.P.L.E. or I.E.S. an advantage.

Details from Town Clerk, Town Hall, London, S.W.6. Closing date, 8th February.

3075

NEW ZEALAND MINISTRY OF WORKS ENGINEERING STAFF

THE NEW ZEALAND MINISTRY OF WORKS invites applications for the following vacancies on the permanent staff. Positions, qualifications desired and salaries offered are as follows :—

Vacancy No. 3 :

MECHANICAL OR ELECTRICAL ENGINEERS.

Corporate Membership of the Institutions of Mechanical or Electrical Engineers, London, together with sufficient appropriate experience. Commencing salaries up to £1,525 p.a.

Vacancy No. 4 :

BUILDING SERVICES ENGINEERS.

Corporate Membership of the Institution of Heating and Ventilating Engineers, London. Commencing salaries up to £1,450 p.a.

Vacancy No. 5 :

ASSISTANT MECHANICAL OR ELECTRICAL ENGINEERS.

A University Degree in Mechanical Engineering or Graduate Membership of the Institutions of Mechanical or Electrical Engineers, London, together with at least five years' experience since commencement of pupilage. Commencing salaries £870 up to £1,060 p.a.

Vacancy No. 6 :

ASSISTANT BUILDING SERVICES ENGINEERS.

Graduate Membership of the Institution of Heating and Ventilating Engineers, London, with at least five years' experience since commencement of pupilage. Commencing salaries £870 to £1,060 p.a.

Experience is necessary in the design and installation of services or equipment for one or more of the following: heating and ventilating, air conditioning, hot and cold water or sewerage services, laundries, kitchens, boiler-houses, lifts and other mechanical services in offices, schools, hospitals, hotels, telephone exchanges, printing works, defence establishments, etc. All appointees will be required to undertake work of this nature.

Applicants must be resident in the United Kingdom or Eire and have fulfilled National Service obligations.

Enquiries, mentioning this publication and stating the vacancy number and the position sought, should be addressed to the High Commissioner for New Zealand, 415, Strand, London, W.C.2. Full details of duties, experience required, general information on the conditions of employment in the New Zealand Public Service and application forms will then be supplied.

2794

PHILIPS ELECTRICAL INDUSTRIES LIMITED

have vacancies for

ELECTRICAL DRAUGHTSMEN

in their

CENTRAL PLANT DEPARTMENT
at CROYDON, SURREY

The work involves the design and layout of power and lighting installations for large factories and office blocks. Candidates should have electrical drawing office experience, and preferably have reached O.N.C. (Elect.) standard.

Commencing salaries will be according to age and experience, and the company's conditions of employment include progressive pension, life assurance, holiday and sick pay schemes.

Applications, in writing, should be addressed to :—

The Personnel Officer (4/ER)
PHILIPS ELECTRICAL INDUSTRIES LIMITED
Waddon House, Stafford Road
Croydon, Surrey

2920

SENIOR ELECTRICAL ENGINEER

FAMOUS Retail Multiple Stores require a SENIOR ELECTRICAL ENGINEER to join a team engaged on the design and planning of engineering installations for new stores.

Candidates should have at least five years' practical experience of electrical contract work connected with the building industry, covering site supervision, estimating and design. They should also be thoroughly familiar with distribution technique, design of control circuits for heating, ventilation and air conditioning, and with modern development in lighting. Preference will be given to candidates previously employed by consultants engaged on large projects. Mechanical engineering experience of heating, ventilation and lift installations would be an advantage.

Applicants should have a Degree in Electrical Engineering and be Associate Members of the Institution of Electrical Engineers. Preferred age 30 to 35. Initial salary in the range of £1,500-£2,000 or up to £2,500 for an exceptional candidate. There are excellent prospects of promotion. Ref. No. 47.

Please reply in confidence, quoting reference number, to :—

Robert Clive (Consultants) Limited
Appointments Consultants
27, ALBEMARLE STREET, LONDON, W.1

3019

SOUTH EASTERN ELECTRICITY BOARD

ASSISTANT DISTRICT ENGINEER, Sutton District.

Salary £765 × £15 to £810 per annum, plus London allowance, under N.J.B. Class G, Grade 11. Superannuable. Applicants should possess the Higher National Certificate in Electrical Engineering and have had a thorough training in underground and overhead distribution systems. Applications quoting ER, and naming 2 referees, on forms from District Manager, SEEBOARD, 52, High Street, Sutton, Surrey, by 3rd February, 1960.

INSTALLATION INSPECTOR, Croydon and Purley District.

Wages 5s. 7¼d. per hour for a 44-hour 5-day week, under N.J.I.C. agreement. Hours will be reduced to 42 per week with the same weekly remuneration from 1.2.60. Superannuation optional after 2 years' service. Applicants must have a sound knowledge of the appropriate regulations and of medium and low voltage metering. Applications quoting ER, and naming 2 referees, to District Manager, SEEBOARD, Electric House, Wellesley Road, Croydon, by 25th January, 1960.

ASSISTANT DISTRICT ENGINEER, Sutton District.

Salary £860 × £15 to £905 p.a., under N.J.B. Class G, Grade 9, plus London allowance. Superannuable. Applicants should have had a good general education, be technically trained up to Higher National Certificate standard and must have had practical experience in general distribution work on H.V. and L.V. systems. Ability to plan and prepare schemes for mains extensions would be an advantage. Applications quoting ER, and naming 2 referees, on forms from Surrey Manager, SEEBOARD, Rough Rew, Ridgeway Road, Dorking, Surrey, by 3rd February, 1960.

GEORGE WRAY,
Secretary.

3054

LONDON ELECTRICITY BOARD

General Assistant Engineers

APPLICATIONS are invited for the above positions. Initially the successful candidates will be located at Battersea, London, S.W.11, or Walthamstow, London, E.17.

Applicants should have a sound technical education to the standard of the Higher National Certificate, and have completed a recognised period of training in the electricity industry, or have equivalent experience.

Pending determination as to the grading and salary applicable to the post within the National Joint Board Agreement, the provisional minimum salary will be within the range £610 per annum rising to £745 per annum, inclusive of London allowance.

Application form obtainable from Personnel Officer, 46, New Broad Street, London, E.C.2, to be returned completed within fourteen days of the publication date of this advertisement.

Please state location preferred and quote ref. PER/V/2799/R.

3060

SOUTH OF SCOTLAND ELECTRICITY BOARD

APPLICATIONS are invited for the undernoted superannuable appointments in the Technical Section of the Chief Engineer's Department :—

1. THIRD ASSISTANT ENGINEER (Protective Gear), Head Office, Cathcart (Ref. ER2/60).

Applicants should possess a Degree or Higher National Certificate in Electrical Engineering, and should preferably have had experience in commissioning high-voltage electrical apparatus and routine maintenance and testing of protective gear. Previous experience at the works of a manufacturer of the above equipment will also be an advantage. The scope of the work embraces equipment in the Board's generating stations and transmission system.

Salary N.J.B. Class AX/EX, Grade 5 or 6, £1,090/£1,355 or £925/£1,170 per annum.

2. FOURTH ASSISTANT ENGINEER (Telecommunications), Kirkintilloch (Ref. ER3/60).

Applicants should have had practical experience of telecommunications equipment, and preferably possess a Higher National Certificate or City and Guilds Final Certificate in Telecommunications. The duties will consist of commissioning and maintenance of the Board's private telecommunications systems, including equipment using automatic exchange, V.F. signalling and radio technique. A knowledge of supervisory control systems and telemetering would be an advantage.

Salary N.J.B. Class AX/EX, Grade 7 or Grade 8, £840/£1,065 or £735/£960 per annum.

Applications, quoting appropriate reference number, should be submitted on the standard form to the Secretary, South of Scotland Electricity Board, Inverlair Avenue, Glasgow, S.4, not later than 5th February, 1960.

3024

SOUTHERN ELECTRICITY BOARD

General Assistant Engineer

ALDERSHOT District of No. 3 (Portsmouth) Sub-Area, located at Petworth. Salary N.J.B. Class G, Grade 12 (£710 × £15 to £755 per annum). N.J.B. conditions of service.

Applicants will be required to assist in distribution duties including minor construction work and general maintenance of H.V. and L.V. overhead and underground distribution systems, substation plant, etc., and possess suitable technical qualifications. The appointment will involve standby duties.

The successful candidate will be required to contribute to the Electricity Supply (Staff) Superannuation Scheme, if eligible.

Applications on forms obtainable from the Sub-Area Secretary, Lower Drayton Lane, Cosham, Portsmouth, and returned to him quoting Z.1155, not later than 1st February, 1960.

3053

***Situations Vacant** (continued)*

ROYAL BOROUGH OF KINGSTON-UPON-THAMES

Appointment of Electrician and Maintenance Engineer

APPLICATIONS invited for appointment of ELECTRICIAN AND MAINTENANCE ENGINEER for the Guildhall to act under control of Borough Surveyor.

Applicants should be qualified electricians having served an apprenticeship, have technical and practical knowledge and a thorough training and experience in running and maintenance of heating, ventilating, lighting and lifts, and be able to carry out routine maintenance adjustments and repairs to electrical installations. Heating is by hot water circulating from storage vessels and electrode boiler (Sulzer Bros. Ltd.).

Rate of pay in accordance with an electrician under Schedule A day rates of the Electricity Supply Industry, i.e., 5s. 2¾d. per hour plus 2½d. per hour (total rate 5s. 5¼d.) for standard week of 44 hours.

Permanent appointment, subject to provisions of the Local Government Superannuation Acts, and passing a medical examination.

The post will be subject to one week's notice on either side.

Applications, stating age, present employment, previous employment and experience, with dates, accompanied by copies of two recent testimonials, must reach the Borough Surveyor at the under-mentioned address not later than 4th February, 1960.

A. B. ROGERS,
Guildhall, Town Clerk.
Kingston-upon-Thames. 3021

FIBREGLASS LIMITED

require a TECHNICAL SALES OFFICER for sales development work in the electrical insulation field.

Candidates should be between 25 and 35 years of age, and preferably have a Science Degree and have served a recognised apprenticeship with an electrical manufacturer, and have a knowledge of electrical insulation.

Applications with full details of career and salary required to Sales Director, Fibreglass Limited, Ravenhead, St. Helens, Lancashire.
2986

Provisional Approvals Board for Domestic Electrical Appliances

DIRECTOR

APPLICATIONS are invited for the post of DIRECTOR OF THE BOARD now being established to undertake the approval, on a national basis, of all domestic electrical appliances.

This is an important post requiring first-class administrative ability and sound judgment.

A background of engineering experience, both technical and commercial, is desirable.

Commencing salary will depend upon qualifications and experience, but will not be less than £3,000, with provision for superannuation. Age not more than about 50 years.

Applications, in writing, which will be treated in strict confidence, to be sent as soon as possible to :—

The Chairman
PROVISIONAL APPROVALS BOARD FOR DOMESTIC ELECTRICAL APPLIANCES
61/62, Lincoln's Inn Fields
London, W.C.2
2988

DRAUGHTSMEN

VACANCIES exist in the Rectifier and Switchgear Division of our organisation for **SENIOR/INTERMEDIATE** and **JUNIOR DRAUGHTSMEN** with experience in the following fields :—

- (a) **Power Rectifiers and Transformers.**
- (b) **Variable Speed Drives.**
- (c) **Motor Control Gear.**
- (d) **Medium-voltage Distribution Boards.**

Good working conditions. Pension scheme. Canteen facilities, etc.

All applications in strictest confidence, quoting ref. T.J.R., to :—

LANCASHIRE DYNAMO NEVELIN LTD.
Hurst Green, Oxted, Surrey
2984

SOUTH WALES ELECTRICITY BOARD

Senior Demonstrator

APPLICATIONS are invited for the position of SENIOR DEMONSTRATOR in the Swansea District of the Swansea and West Central Area of the Board.

Candidates must be competent to give demonstrations and lectures in public halls, consumers' houses or showrooms on cooking, laundering or housecraft subjects. They should also have sales ability for showroom duties and a good knowledge of electrical appliances.

The qualifications required are the diploma of a recognised domestic science college or the Demonstrators' Certificate, and candidates should hold the E.A.W. Certificate.

The person appointed will be required to take part in the agreed rota of Saturday working.

The salary for the position will be in accordance with Grade 2 (£640/£700) of the National Joint Council (Administrative and Clerical Grades) Agreement for the Electricity Supply Industry.

Applications stating age, qualifications, experience and particulars of present duties should be addressed to the Secretary at St. Mellons, Cardiff, so as to reach him not later than Monday, 29th February, 1960.

Envelopes should be marked "Senior Demonstrator, 8/60." 3066

APPRENTICE MASTER (ELECTRICAL)

required by UGANDA GOVERNMENT Public Works Department on contract for tour of 30-36 months in first instance. Gross salary according to experience in scale £813 rising to £1,341 a year. Gratuity at rate 13½% of total salary drawn. Outfit allowance £30. Free passages. Liberal leave on full salary.

Candidates, preferably under 45 years of age, must have served a full apprenticeship as an electrician, have had considerable subsequent practical experience, and possess O.N.C. (Electrical). Candidates having some experience in training electrical craft apprentices in a large organisation would be preferred.

Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience, and quote M2A/50710/EF. 3067

EASTERN ELECTRICITY BOARD

Fens Sub-Area

Draughtsman, Sub-Area Headquarters
12/60.R

APPLICATIONS are invited for the position of DRAUGHTSMAN at Milton Hall. Candidates should have good cartographic experience and be capable of maintaining records. Some building drawing experience would be an advantage.

Salary N.J.C. Grade 2 (£640-£700).

The successful candidate will be required to contribute to a superannuation scheme and may be required to undergo a medical examination.

Apply by letter to the Secretarial Officer, Fens Sub-Area, Eastern Electricity Board, Milton Hall, Milton, Cambridge, by 5th February, 1960.
3042

COUNTY BOROUGH OF CROYDON

Electrical Engineering Assistant

APPLICATIONS are invited for this superannuable appointment in the Borough Engineer's Department from persons who are suitably qualified.

Duties mainly preparation of specifications and drawings for electrical installations in all types of buildings.

Salary scales, £785 to £910 p.a. (progressing to £1,100 p.a. when fully qualified) or £815 to £1,100 p.a. with Part II of the examination.

Commencing salary according to experience at any point within the appropriate scale.

Write to Borough Engineer, Town Hall, Croydon, for further particulars and application form.

Closing date 8th February, 1960.

E. TABERNER,
Town Clerk.
3051

BRUCE PEEBLES & CO. LTD.

East Pilton, Edinburgh, 5

require a

SENIOR TRANSFORMER DESIGNER.

Applicants should have wide experience in transformer drawing office practice and particularly on units of the largest ratings and highest voltages.

Salary will be in accordance with ability and experience.

Applications will be treated in confidence and should be addressed to the Chief Engineer.
3013

QUALIFIED ELECTRICAL ENGINEERS

wanting a chance to escape from large organisation hackwork and off-the-shelf stereotyped products are invited to apply to :—

MAWDSLEY'S LIMITED
Dursley, Glos.

makers of special-purpose rotating electrical machines from 1 to 500 kVA,

and

SPECIALISTS IN SPECIALS.

Applicants must be works trained in the above type of product, A.C. and D.C., and in control gear, and have either :—

(1) 10-15 years' design experience, or
(2) Indoor commercial experience.

Full details (which will be treated in strictest confidence) of age, training and experience to the Personnel Adviser, marked "CONFIDENTIAL." Salaries will be discussed at interviews.
2989

A.E.R.E., HARWELL

requires a

PROFESSIONAL ELECTRICAL ENGINEER

for work on the 7 GeV Proton Synchrotron and a Proton Linear Accelerator. Work includes :—

- Research and development.
- Commissioning and maintenance of high-power R.F. equipment.
- Power supplies.
- Control and monitoring.

Applicants should have relevant experience and a knowledge of high-vacuum techniques would be an advantage.

Salary: £860 (at age 25)—£1,340 p.a.
Housing and superannuation schemes.

Send POSTCARD for details to Group Recruitment Officer (1558/48), U.K.A.E.A., A.E.R.E., Harwell, Berks.

2990

STAFFORDSHIRE COUNTY COUNCIL EDUCATION COMMITTEE

Stafford College of Technology

Principal: R. S. Paradise, B.Sc.(Eng.) Hons., M.I.Mech.E., A.M.I.Mar.E.

APPLICATIONS are invited for the post of LECTURER in the Department of Electrical Engineering. Candidates should be University Graduates in Physics including Electronics. Teaching and/or research experience would be an added qualification.

Salary Burnham Technical Scale for Lecturers, viz., £1,370 × £35 to £1,550.

Form of application, returnable by 6th February, 1960, and further details relating to the appointment may be obtained from the undersigned on receipt of a stamped addressed foolscap envelope.

J. H. P. OXSPRING,
Dept. F.E., Director of Education.
County Education Offices,
Stafford.

3055

CENTRAL ELECTRICITY GENERATING BOARD

Midlands Division

STATION SHIFT CONTROL ENGINEER is required at Meaford A Power Station. N.J.B. service conditions, superannuable appointment, salary within Schedule A of the agreement, Grade G10, £815-£860 per annum, plus £90 shift allowance.

A sound technical training and practical experience in the control of steam generating plant and main switchgear are required. Appropriate technical qualifications an advantage.

Apply quoting vacancy number MD.9/60, on form AE6, available from the Establishments Officer, 53, Wake Green Road, Moseley, Birmingham, 13, by 1st February, 1960. 3049

HUMPHREYS & GLASGOW LIMITED

require Electrical Engineers in connection with chemical and gas plant design for their London Office.

(a) ELECTRICAL ENGINEERS experienced in design of complete power and lighting installations. Must be able to prepare complete schemes and specifications for lighting and heating, and handle contracts from enquiry to commissioning. Minimum qualification A.M.I.E.E.

(b) ELECTRICAL ASSISTANTS with sound practical experience and preferably some drawing office experience / work with electrical engineers. Minimum qualification O.N.C., studying for H.N.C.

Apply in writing to D. W. Eagle, Electrical Engineer, Humphreys & Glasgow Ltd., 22, Carlisle Place, London, S.W.1.

3012

LONDON ELECTRICITY BOARD

Vacancy: Commercial Engineer

APPLICATIONS are invited for the above position in the Board's Regency District. Applicants should have had experience of consumers' service, development, tariffs, statistics, electrical contracting and maintenance, the design of space and water heating installations and the operation of service centres, etc. Corporate Membership of the Institution of Electrical Engineers would be an advantage.

The post is graded under Schedule A of the National Joint Board Agreement as Class J, Grade 6, £1,245 per annum to £1,320 per annum, inclusive of London allowance.

Application form obtainable from Personnel Officer, 46, New Broad Street, London, E.C.2, to be returned completed within 14 days of the publication of this notice. Please quote ref. PER/V/2834/R. 2985

CENTRAL ELECTRICITY GENERATING BOARD

South Wales Division

Vacancy No. 8/ER/60

APPLICATIONS invited for superannuable N.J.B. appointment of STATION CHEMIST, TIR JOHN POWER STATION, SWANSEA.

Salary Class H, Grade 7 (£1,025-£1,085 per annum).

Applicants should possess B. Sc. (Chem.) and/or A.R.I.C. and have experience in water treatment, coal and oil testing and corrosion problems.

Special application forms obtainable from Divisional Secretary, South Wales Division, Central Electricity Generating Board, Twyn-y-fedwen Road, Gabalfa, Cardiff, to be returned by 30th January, 1960. 3010

Expanding British Company in Iran
requires

ELECTRICAL CONTRACTING BRANCH MANAGER

Previous experience of managing a contracting organisation in all its aspects is essential. Minimum age 30.

Commencing salary including allowances will be in the region of £3,500, but will be dependent upon experience and ability. Company car provided.

Write giving fullest particulars of marital status, past experience, employers and periods of employment, quoting reference M.T.1, to—Box 3011.

NORTH EASTERN ELECTRICITY BOARD

Harrogate Sub-Area

APPLICATIONS are invited for the appointment of SECOND ASSISTANT ENGINEER (Survey), Harrogate Sub-Area Headquarters. Applicants should be suitably qualified engineers with a basic knowledge of H.V. and L.V. overhead line design and construction methods. Experience in surveying of overhead line and cable routes, including the preparation of erection schedules, is essential.

Applications stating age, qualifications and experience to be received by Assistant Secretary (Establishments), North Eastern Electricity Board, G.P.O. Box No. 117, Carliol House, Newcastle upon Tyne, within ten days of the appearance of this advertisement. 3057

MONTGOMERYSHIRE EDUCATION COMMITTEE

County Technical School, Newtown: Further Education Department

REQUIRED as soon as possible, an ASSISTANT to teach Electrical Engineering, chiefly Electrical Installations Course B and ancillary subjects for City and Guilds. Payment at Grade B for suitably qualified candidate.

Application forms may be obtained from the undersigned.

J. A. DAVIES,
Director of Education.
County Education Offices,
Newtown, Montgomeryshire. 3056

INSTRUMENT TRANSFORMER DESIGNER

APPLICATIONS are invited from suitably qualified men with experience in this field. The post is permanent and pensionable and carries good prospects.

Modern factory, with excellent canteen facilities.

Applications stating age, training and experience to:—

Employment Manager,
JOHNSON & PHILLIPS LTD.
Victoria Way, Charlton, London, S.E.7

3064

NORTH WESTERN ELECTRICITY BOARD

District Commercial Engineer, Macclesfield District

DUTIES will include the organisation and control of commercial staff and functions in the District; supply of information and advice to consumers on all commercial matters; control of contracting section, service centres and exhibitions. Corporate Membership of the Institution of Electrical Engineers will be an advantage.

Salary scale £1,360 × £30 to £1,450 p.a., Grade G.2. N.J.B. conditions.

Applications must be made on a form to be obtained from the Manager, No. 3 Sub-Area, North Western Electricity Board, Union Street, Oldham, and returned to him so as to be received not later than 3rd February, 1960.

3025

THE UNIVERSITY OF LIVERPOOL

APPLICATIONS are invited for the post of SENIOR LECTURER or LECTURER in the Department of Electrical Engineering (Electronics).

The salary range for a Senior Lecturer is £1,700-£2,050 per annum and that for a Lecturer £900-£1,650. The initial salary for a Senior Lecturer will be £1,700 per annum or within the range £900-£1,500 per annum for a Lecturer, according to qualifications and experience.

Applications, stating age, academic qualifications and experience, together with the names of three referees, should be received not later than Saturday, 13th February, 1960, by the Registrar, from whom further particulars of the conditions of appointment may be obtained. Quote ref. CV/ER. 2992

MERSEYSIDE AND NORTH WALES ELECTRICITY BOARD

No. 2 Sub-Area

ASSISTANT SECTION ENGINEER required in the St. Helens District. Salary within range £860/£905 per annum (N.J.B. G/9).

Applicants should have received an engineering training and have had experience in H.V. and M.V. overhead and underground distribution work. Technical qualifications desirable.

Appointment subject to medical examination. Pension scheme.

Application forms obtainable from the Manager, No. 2 Sub-Area, Sandiway House, Northwich, Cheshire. Closing date 1st February, 1960. 3062

SALES ENGINEER

HADDON TRANSFORMERS Ltd. wish to engage a suitably qualified and experienced Engineer for negotiating the sale of Transformers and Saturable Reactors, 1-250 kVA, to industrial purchasers in the London and Home Counties areas.

Applications in confidence, giving full details of experience, to :—

The Managing Director
HADDON TRANSFORMERS LTD.
Victoria Park Industrial Estate
Field End Road, Ruislip, Middlesex

2805

***Situations Vacant** (continued)*

NORTH WESTERN ELECTRICITY BOARD

Appointment of Secretary

APPLICATIONS are invited from suitably qualified and experienced persons for the post of SECRETARY on a salary within the range £3,500 to £4,000 per annum.

Applications must state age, salary, experience and present position and responsibility of the applicant, together with the names of three referees.

The closing date is 5th February, 1960.

Correspondence must be addressed to :—

Mr. T. E. Daniel,
Chairman,
North Western Electricity Board,
Cheetwood Road,
Manchester, 8. 3026

ELECTRONIC ENGINEER

A YOUNG Electronic Engineer with a fairly broad background of design experience in the R/F field is required for the design laboratory of a medium-sized firm of cable and T.V. aerial manufacturers. This is a responsible position in an expanding company, and the man selected will have initiative, enthusiasm and experience in R/F measurement techniques at VHF and UHF for the advanced development of high-frequency cable and associated electronic equipment.

B.Sc., H.N.C. or equivalent qualification essential equipment for successful candidate.

Design men looking for scope in a smallish design team should write with full details of their experience to Chief Designer, Aerialite Ltd., Castle Works, Stalybridge, Cheshire. 3028

THE WALLACETOWN ENGINEERING CO. LTD.
Viewfield Road, Ayr, Scotland

SENIOR DESIGNERS.

(1) Experienced in the design of medium voltage motor control gear and ancillary equipment.

(2) Experienced in the design of flame-proof mining control gear.

PRODUCTION ENGINEER.

Experienced in all sections of machine work, light fabrication and component assembly.

All applications will be treated in strictest confidence. Apply first in writing to the Secretary. 3023

ELECTRICAL ENGINEER (QUALIFIED)

A VACANCY exists for a qualified Electrical Engineer with a Hydro-Electric Power Undertaking in Northern Nigeria. Pleasant climate, 4,000 feet above sea level. Age 30 to 35.

Salary grade £1,335/£1,565 according to age, qualifications and experience. Pension and life assurance scheme. Eighteen months' tours with three months' leave on full salary. Free furnished quarters. Free passages self, wife and two children, or equivalent benefits if children remain at home.

Write Box D.401, c/o Streets, 110, Old Broad Street, London, E.C.2. 2994

L.C.C. SOUTH-EAST LONDON TECHNICAL COLLEGE

GRADE B LECTURER to teach up to H.N.C. standard in Electrical Engineering Department. Graduate preferred.

Salary (men) within the range £738 to £1,486; point of entry and maximum depending on age, qualifications, training and experience.

Application forms from Secretary at College, Lewisham Way, London, S.E.4, returnable within two weeks of advertisement date. (2900) 2991

ELECTRICIANS

ELECTRICIANS required for general maintenance and installation work on large integrated iron and steel works. Excellent conditions. Pension scheme in operation.

Apply to the Employment Officer, Appleby-Frodingham Steel Company, Scunthorpe, Lincs. 2864

SWITCHGEAR DRAUGHTSMEN

DEVELOPMENT and CONTRACT DRAUGHTSMEN with experience of switchgear up to and including 33 kV required by Johnson & Phillips Ltd., at their new switchgear factory at New Cross or at a drawing office in Central London.

5-day week, good salary, pension scheme, excellent staff conditions.

Applications stating age, experience, etc., to:—

Employment Manager,
JOHNSON & PHILLIPS LTD.
Charlton, London, S.E.7

3065

BOROUGH OF HORNSEY

ASSISTANT MAINTENANCE ENGINEER required for Town Hall. Applicants should have experience in large public buildings and multi-purpose halls. Wage £14 (including overtime). Sick pay. Superannuation if under 45. Write Borough Engineer, Town Hall, London, N.8, for application form.

W. B. MURGATROYD,
Town Clerk.
3020

A QUALIFIED electrical engineer, age 30-40, required in Edinburgh, to take charge of consulting engineers' electrical section.—Box 3072.

A WORTHWHILE career, sharing in the expansion of a well-established electrical accessory manufacturer based in the Manchester area, is offered to a man with initiative and experience in the trade. It is intended to create a new division in the company and we are looking for a top-class salesman with managerial ability, who will take over, promote and eventually control the sales activity of this division. A worthwhile salary, commission and expenses will be paid, a car is provided, and a pension scheme is in operation. Only experienced men need apply, giving full details to—Box 2996.

AGENT-representative required for the London area by specialist manufacturer for purpose-made control panels.—Box 2963.

AN electro-mechanical draughtsman required by engineering company. Must be capable of detailed design and systematic handling of various projects. 5-day week, canteen, pension fund. Apply in writing stating age, previous experience, qualifications, if any, to—Personnel Officer, Dewhurst & Partner Ltd., Inverness Road, Hounslow, Middlesex. 2964

AN engineering insurance company requires an engineer for appointment as inspecting engineer of electrical plant. Candidates must possess H.N.C. in Electrical Engineering or equivalent and have served an apprenticeship with a manufacturer of electrical machinery. Apply in own handwriting to the National Boiler and General Insurance Co. Ltd., St. Mary's Parsonage, Manchester, 3, giving age (limits 26 to 33), training and experience, academic qualifications and copies of testimonials. Salary £800-£1,100 (progressive). Non-contributory pension scheme. 2841

APPLICATIONS are invited from ambitious and resourceful men to fill the position of technical assistant to the sales manager of electric lamp machinery manufacturers near London. A permanent, progressive and interesting job is offered to the right person, who must possess a sound engineering and commercial background in the trade. Applications with full particulars of education, experience and salary required to —Box 328.

CABLE engineer for A.E.I., Cable Division. An opportunity exists for a fully qualified engineer to take control of development in the super-tension cables and accessories dept. of the newly formed cable division. The post is London based and is permanent and pensionable. Salary will be in the region of £2,000, although a higher figure will be considered in the case of applicants possessing broad experience and a special aptitude for high-voltage work in this field. Please write with full details to Staff Officer, Ref. 744/2/ER, Associated Electrical Industries (Woolwich), London, S.E.18. 2997

BRITISH ENGINE BOILER & ELECTRICAL INSURANCE Co. Ltd., Longridge House, Manchester, 4. Electrical surveyors required in England and Scotland. Permanent positions carrying progressive salary scale £800 to £1,100 with non-contributory pension. Candidates, aged 26 to 32, with H.N.C. in Electrical Engineering or Grad. I.E.E., and with apprenticeship in manufacture or repair of electrical machinery, are invited to apply stating age, qualifications and experience. 3017

CABLE jointers. Large manufacturers require cable jointers having previous experience of all classes of work up to and including 22 kV and "live" L.T. jointing. London rates of pay and out allowance. Applicants would be required to travel to any part of the country, and should write stating age and brief details of previous experience to—Box 3029.

CHECKERS and senior draughtsmen are required for the design of complete electrical installations for oil refineries, chemical plants and similar projects. Pension and life assurance scheme. Apply in writing stating age, qualifications, experience and salary required to — Foster Wheeler Ltd., 3, Ixworth Place, London, S.W.3. 2987

CHIEF inspector required for cable works, manufacturing rubber and plastic cables, cordages and wires, mainly for the telecommunication industry. Experience of the various Government inspecting procedures essential. A knowledge of modern manufacturing methods and testing techniques would also be an advantage. Write details to Reliance Cords & Cables Ltd., Staffa Rd., Leyton, London, E.10. 9907

CIRCUIT draughtsman. Young man, age 22/35, required for circuitry work associated with automatic control gear. O.N.C. standard preferred. Permanent and progressive position. Pension fund, canteen. Apply in writing giving full details of age, experience and qualifications, if any, to Personnel Officer, Dewhurst & Partner Ltd., Inverness Road, Hounslow, Middx. 2966

CIRCUIT engineer required for development work. Previous experience of control gear desirable. Minimum academic qualifications H.N.C. Permanent and pensionable position. Please write giving full details of age, experience, etc., to—Personnel Officer, Dewhurst & Partner Ltd., Inverness Road, Hounslow, Middx. 2965

CONTROL gear engineer required, age 23/35, for layout and circuiting of contactor equipment. Experience of lift equipment would be an advantage. Permanent and progressive position. Good salary. Canteen, pension fund. Write stating age, experience and qualifications, if any, to — Personnel Officer, Dewhurst & Partner Ltd., Inverness Road, Hounslow, Middlesex. 2967

DESIGNER-draughtsman for electric lighting fittings. London area. Good prospects. 5-day week. Apply stating age, experience and salary required to—Box 2885.

DRAUGHTSMAN required by medium-sized company for interesting work on electrical accessories. Age preferably in the range 25/35. Minimum qualification O.N.C. and experience in this or a similar field. Ample scope and opportunity for the right man. Write stating age, experience and salary required to the Wandsworth Electrical Mfg. Co. Ltd., Albert Drive, Sheerwater, Woking, Surrey. 3069

ELECTRICAL contractors' draughtsman with some experience of estimating required by Kuwait Associates. Salary £1,000-£1,200 per annum. Free furnished accommodation. Cost-of-living allowance £37 10s. per month. Single man preferred as no married accommodation available for first two years. Contract on yearly basis with option of renewal. Paid leave at rate of 36 days per annum on total overseas service if tour extended to second year. Applications, stating age and experience, to—Drake & Gorham (Contractors) Limited, 36, Grosvenor Gardens, London, S.W.1. 2886

ELECTRICAL design engineer required by London contractor. Applicants should possess H.N.C. or equivalent and be a graduate of the I.E.E., and should preferably have served an apprenticeship with an electrical contractor or manufacturer and should have subsequently had drawing office experience and at least 4 years' installation design experience including H.V. and M.V. distribution, power and lighting and the preparation of drawings, specifications and tenders. Age group 25 to 40 preferred, but applicants outside this group will be considered. Salary £900 to £1,100 depending on age, experience and qualifications. Please write giving full details in strictest confidence.—Box 2999.

ELECTRICAL engineer required by London consulting engineers for preparation of design, specifications, etc., for schools, hospitals and commercial buildings, etc. Write stating age, experience, qualifications and salary required to—Box 160.

ELECTRICAL engineer required for head office staff. Degree or graduate membership of I.E.E. and practical training at manufacturer of electrical machines. Upper age limit 35. Progressive salary with non-contributory pension. Applications stating age, nationality, qualifications and experience to British Engine Boiler & Electrical Insurance Co. Ltd., Longridge House, Manchester, 4. 3018

ELECTRICAL engineer required for London consulting engineers' office. Applicants should be Associate Members of the I.E.E. and experienced in the complete design of electrical services in hospitals, universities, colleges, etc. —Box 2773.

ELECTRICAL engineer with H.N.C. or equivalent required for supervision of site installation by manufacturers and electrical contractors of large rotating machinery associated with compressor drives, switchgear, power and control cable services, lighting and heating installations, all associated with turnkey air separation plant. Must be prepared to travel within the U.K. and spend periods on site. Apply Personnel Manager, Air Products (G.B.) Ltd., 49/50, Poland Street, London, W.1. 3001

ELECTRICAL engineers and contractors, specialising in heavy industrial and commercial installations, require a qualified electrical engineer experienced in supervision, etc. State education, experience, salary required.—Electrobuild Ltd., 117, Uxbridge Road, London, W.12. 9905

ELECTRICAL estimating engineer. Applicants should preferably be in possession of O.N.C. or City and Guilds and should have served an apprenticeship with an electrical contractor and have had estimating experience and be fully conversant with specifications, forms of contract, etc., for all types of electrical contracting work. Age group 25-40 preferred, but applicants outside this group will be considered. Salary £800 to £1,000 depending on age, experience and qualifications. Please write giving full details in strictest confidence.—Box 3000.

ELECTRICAL installation engineer required for large company in N.W. London. Applicants should have experience of planning, estimating and should be capable of supervising and controlling contractors. Starting salary will not be less than £1,000.—Box 3031.

ELECTRICAL tester. The type of man we require should have previous experience of testing control gear, be capable of working with the minimum of supervision, and have a clear understanding of the principles of electric motors. 5-day week, canteen, pension fund. Apply in writing stating age, previous experience, etc., to—Personnel Officer, Dewhurst & Partner Ltd., Inverness Road, Hounslow, Middlesex. 2968

ELECTRICIAN/electrical mechanic, first class, experienced installation work, required by large electrical concern; 12 months' service overseas. Excellent opportunity. Write experience, age, references.—Box 2828.

ELECTRONIC engineer to assist in design department in development of medium power transistor control circuits. Knowledge of alternators, D.C. motors and magnetic amplifiers an advantage. Reply in writing stating age, experience and technical training to W. Mackie & Co. Ltd., 129/133, Lambeth Road, London, S.E.1. 3030

ENERGETIC sales engineer required for Midlands area to develop sales of a wide range of M.V. switchgear preparatory to establishing a depot. Connections desirable with consultants, leading contractors, electricity board and industrial users for cubicles, metalclad switchboards, complete range of fuse and switchgear, substation boards, feeder pillars, busbar trunking. Please give full experience, present salary, etc., in confidence to Managing Director, G. P. Dennis Ltd., Speke, Liverpool. 2927

ENGINEER required to take complete charge of wood pole distribution scheme in North-East Scotland. Only men having held similar positions considered. Apply in writing—B. French Ltd., Pike Mills, Kidderminster. 3014

LEADING rotary switch manufacturers wish to appoint a number of representatives. Good connections are essential and will qualify for generous remuneration and expenses.—Box 3033.

ENGINEERS required for the erection of steel tower and wood pole overhead transmission lines, at home or overseas. Applicants should have a general engineering background. Experience desirable but not essential. Pension fund. Apply in writing to Staff Officer, British Insulated Callender's Construction Co. Ltd., 30, Leicester Square, London, W.C.2. 3032

ESTIMATING engineer for electrical contracting work with a wide experience of large industrial and commercial installations. Applications to be in writing, giving full details of training, qualifications, experience and salary expected.—W. J. Furse & Co. (Manchester) Ltd., 20, Mount Street, Manchester, 2. 2969

ESTIMATOR required for electrical contracting department of progressive West London firm. Must be fully conversant with all types of installations for business and industrial premises and should have previously held similar post. Please submit details of training and experience to—Box 2913.

EXCELLENT prospects for contract engineers and supervisors experienced in electrical cable work, overhead line transmission and installations, Midlands and Southern England. The aim of the company is expansion with obvious promotion opportunities. Apply giving full particulars. Early interviews arranged. —Box 325.

MALE invoice clerk required by electrical wholesale company S.E. London. Knowledge of electrical industry essential. 5-day week. Write stating age, experience, salary required.—Box 2971.

MANAGER required by electrical contractor in Birmingham, engaged on school, hospital and industrial installations. Must have sound estimating, technical and administrative ability and capable of handling contracts from enquiry to final accounts. Application in confidence with fullest details of experience, positions held and approximate salary received. —Box 9899.

PLANT engineer: If you have a good honours degree in electrical engineering or Corporate Membership of the Institution of Electrical Engineers, and would like a responsible position in a processing works of the Commonwealth's largest glass manufacturing organisation, you are invited to write direct to the Works Engineer, City Road Works, Pilkington Brothers Limited, St. Helens, Lancashire, quoting ref. CRPE/11. You would be responsible for supervising planned maintenance, both mechanical and electrical, of plant and buildings worth £1,000,000, estimating capital electrical projects, negotiating contracts and general plant development. The power source of the works is entirely electrical, 160,000 kWh per week. You would have ample scope for initiative and responsibility and there would be opportunity for further promotion within the group. 3068

PLUMBER jointers, H.V. and L.V., required for contracting work. Applicants should be willing to undertake a trade test.—Box 2868.

PROGRESSIVE opportunity in modern high-voltage laboratory to carry out interesting development work. Applicant should have degree or H.N.C. in electrical engineering, with some experience of testing techniques and ability to work on own initiative. Please send full information, including details of experience and salary required, to Managing Director, Doulton Industrial Porcelains Ltd., Wilnecote, Tamworth, Staffs. 2998

SALES clerks (semi-senior) for customer liaison duties. Experience of cables and flexibles an advantage. Permanent progressive post. Details positions held, present salary to Reliance Cords & Cables Ltd., Staffa Road, Leyton, London, E.10. 9900

SALES engineer to operate from London office of leading manufacturers of electric motors and generators. Pension scheme. Bonus and opportunities of promotion for young man with the right personality and qualifications. Write in confidence giving full details of age, education, training, experience and salary required to—Box 2888.

SENIOR electrical draughtsmen (design) required for Northern Ireland, having experience particularly in the ranges of induction motors 1 to 200 h.p. and 200 to 2,000 h.p. Additional experience in alternators an advantage. Good salaries. Progressive positions. Pension scheme. Reply giving full particulars of age, qualifications and experience to—Box 2974.

SALES engineers with established connections in the London, Birmingham and Leeds area to represent a well-established company manufacturing motors and electric control gear. Apply in confidence with full details to—Box 2928.

SUPERVISING engineer, fully experienced for London installation contractors. This is a senior post and applicants must have held similar grade for number of years. Excellent prospects, good salary and pension scheme. When applying state age and give full details of past experience.—Box 9902.

SUPERVISING engineer required by electrical contractors. Able to prepare schemes and estimates and carry through to account stage. Permanent, pensionable situation. Write W. J. Furse & Co. (London) Ltd., 22, Alie Street, London, E.1. 3034

SUPERVISOR. A progressive position is offered by a well-established firm of contractors operating from London to a man with experience and a keen sense of responsibility. Please forward full details to—Box 2900.

SUPERVISOR or foreman required for electrical contracting business. Fully experienced in handling medium-sized contracts. Some knowledge of pricing an advantage. Write giving full details of experience and salary required to—Hamilton Cole (Sussex) Ltd., 201, Heene Road, Worthing, Sussex (Telephone, Worthing 1961/1887). 2872

SUPERVISOR/estimator required for East London (Essex) contractors. Must be capable of handling contracts up to £50,000. Good knowledge of M.I.C.C. essential. Details of experience and salary required to—Box 3070.

TECHNICAL representative (25 to 40) required to call on architects, consultants and contractors in Lancs and Cheshire. Knowledge of power distribution systems essential. Design experience an advantage. Please state salary required, age, qualifications and experience to —Box 2816.

TRANSFORMER test engineer required, preferably experienced in high-voltage on load taking equipment.—Box 3015.

TWO assistant electrical engineers required by large firm architects Central London; H.N.C. or O.N.C. standard only. Apply giving personal details, education, experience, salary required.—Box 2817.

YOUNG graduate electrical engineer required for work on electrical installation connected with development schemes relating to the roadstone industry. The position is progressive and has future prospects. Written application giving full details of qualifications and experience should be sent to Development Manager, Tarmac Roadstone Limited, Ettingshall, Wolverhampton. 3016

APPOINTMENTS FILLED

Dissatisfaction having so often been expressed that unsuccessful applicants are left in ignorance of the fact that the position applied for has been filled, may we suggest that Advertisers notify us to that effect when they have arrived at a decision? We will then insert a notice free of charge under this heading.

SITUATIONS WANTED

BUYER seeks sit., contractor or wholesaler, Central or N.W. London; fully experienced all depts.—Box 9908.

CHARTERED electrical engineer (38) with export sales experience seeks position as commercial executive with switchgear/motor/transformer/electronics manufacturer in Surrey area. Prepared to invest some capital.—Box 9888

ELECTRICAL fitter (35), O.N.C., apprenticed, prepared to travel for progressive post. Write—Harris, 708, Christchurch Road, Bournemouth. 9892

ELECTRICIAN (29), apprentrice trained, requires progressive position.—Box 9889.

MANUFACTURERS' representative, contacts wholesalers, retailers, users, London area, desires change.—Box 9895.

REPRESENTATIVE, progressive, organising ability, technical experience domestic and industrial, car, office, phone, requires post electrical representative or agent Midlands.—Box 9897.

RESIDENT electrical domestic appliance representative for S.E. England open to offers from reputable firm.—Box 9909.

Situations Wanted (continued)

SALES engineer, A.M.I.E.E. (40) requires appointment; 12 years' outside sales experience H.V./L.V. switchgear and power factor correction capacitors.—Box 9906.

SUPERVISING elec. engr. (32) exp. contracting, maintce., estimat'g; car owner—Box 9901

SALES BY AUCTION

Forty-fifth Sale

E R

By Order of the Secretary of State for War.

M.O.A. STORAGE DEPOT, RUDDINGTON
(Five miles south of Nottingham on the main Nottingham-Loughborough road).

WALKER, WALTON & HANSON
(in association with
Turner, Fletcher & Essex
and
Richardson & Linnell)
will Sell by Auction on
TUESDAY, 2nd FEBRUARY, 1960
at 10.30 a.m.
a Large Quantity of

GOVERNMENT SURPLUS PLANT AND STORES

including Newall Universal Rigid Lap Machine, Hordon Mason & Edwards Single Action Power Press, Spot Welders, Annealing, Cutting, Trimming and Tapering Machines, White Circular Saw Bench, Bliss Draw Presses.

Webbing, Canvas Canopies, Kraft Creped and Waterproof Paper, Hessian Wrappers and Paper Backed Hessian, Rotproof and Cotton Twine, Rope and Cordage, Khaki Drill Skirts, Motor Cyclists' Boots, Rubber Thigh Boots, Textiles, Clothing, Footwear, etc.

2 and 4½-gallon Petrol and Water Cans, Tyres, Tubes, Flaps and Wheel Assemblies, Seats and Cushions, 225 Lead Acid Accumulators (6 and 12 volts), Towing Ropes, Hydraulic and Screw Jacks, Fire Extinguishers, Waterproofing Kits, Linseed Oil, Tyre Foot Pumps, Tyre Inflators, Mechanical Tyre Pumps, Carburettors, Generators and other M.T. Spares, Leather Tool Bags, Auxiliary Charging Sets, Vehicle Metal Cabs and Truck Bodies, Storehouse Trucks, Hand Stackers, Coventry Climax Fire Pumps, Folding Tables, Chairs, Cupboards and Filing Cabinets, Refrigerators, etc.

6,575 ft. 14" and 18" Gravity Roller Conveyor Straights.

FOR VIEWING DATES AND TIMES SEE PAGE VIII IN THE CATALOGUE.

CATALOGUES, price 1s. each (Postal Orders only) to admit TWO PERSONS to View and ONE PERSON to the Sale, may be obtained from the Auctioneers' Offices, Dept. 3, Byard Lane, Bridlesmith Gate, Nottingham, from 19th January onwards.

Tel. Nottingham 54272 (7 lines).

3004

ARTICLES FOR SALE

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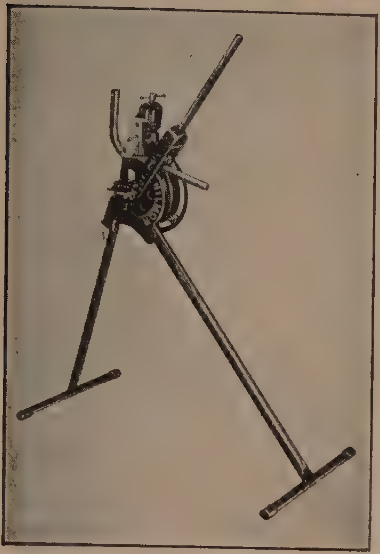

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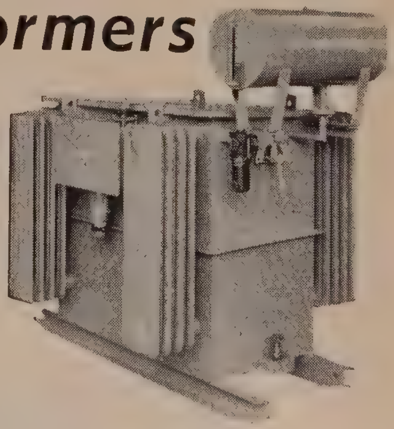

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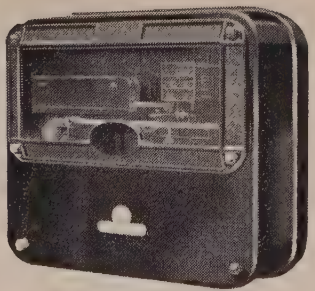

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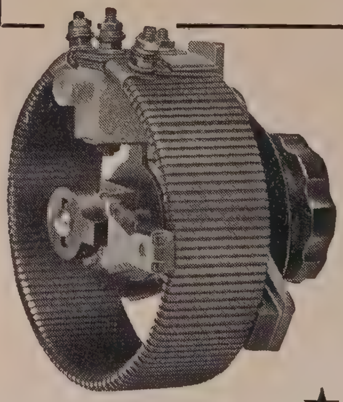

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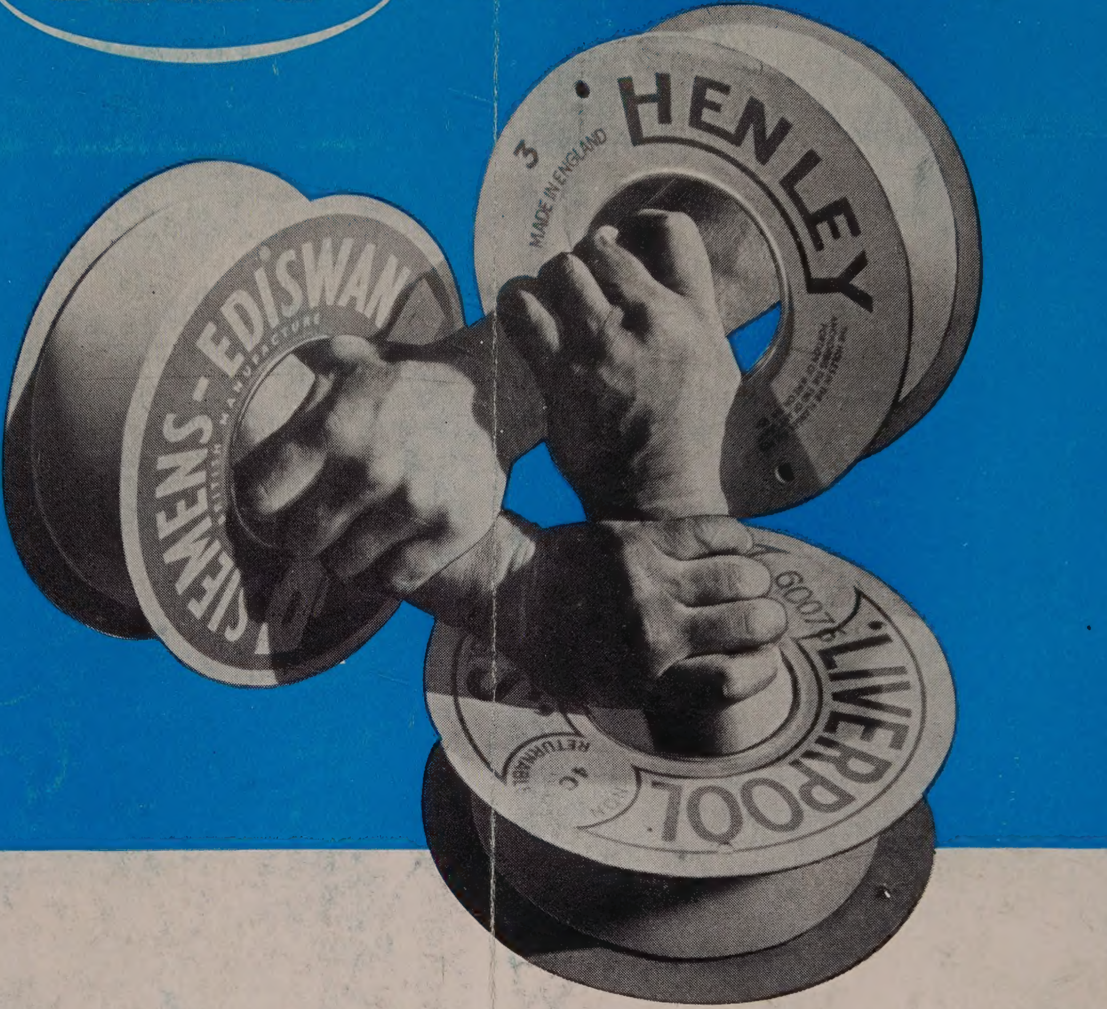

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